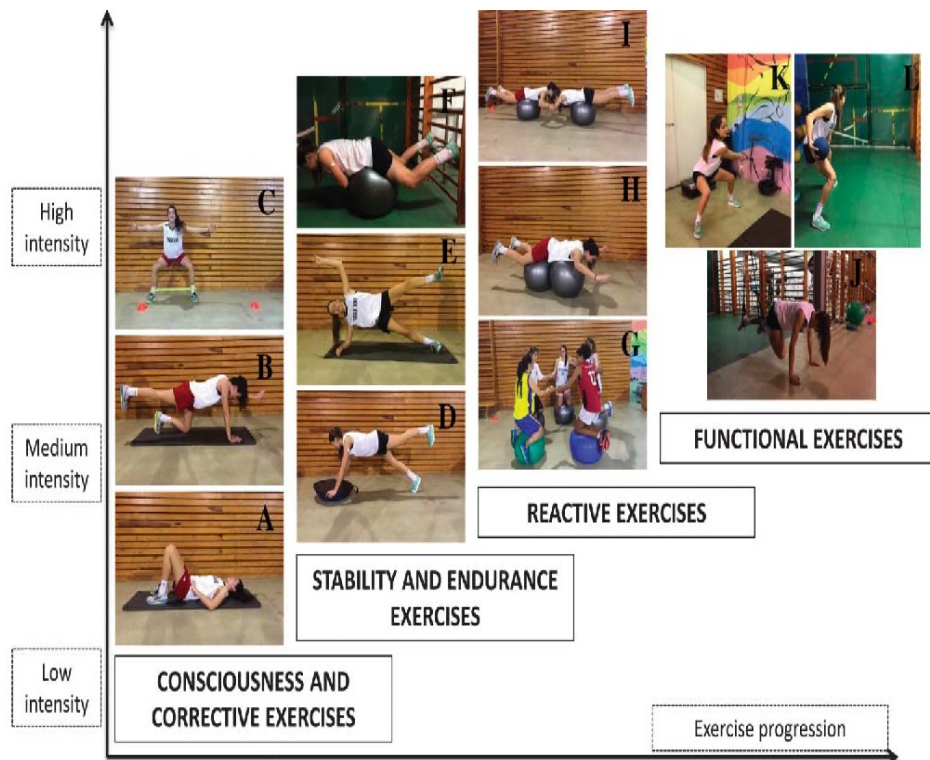


**IMPACT OF SPECIFIC SKILL AND NEUROMUSCULAR
TRAINING ON SELECTED PHYSICAL, PHYSIOLOGICAL
AND SKILL RELATED VARIABLES AMONG STATE
LEVEL MALE JUNIOR BADMINTON PLAYERS**

Dr T Ganesh Kumar



Department of Physical Education and Sports



Dr. M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
DEEMED TO BE UNIVERSITY

University with Graded Autonomy Status

(An ISO 21001 : 2018 Certified Institution)

Periyar E.V.R. High Road, Maduravoyal, Chennai-95. Tamilnadu, India.



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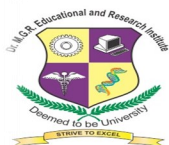
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Book Version of the PhD Thesis
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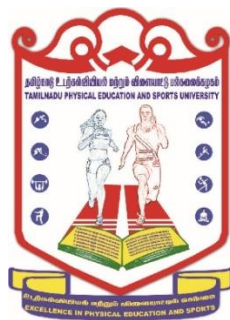
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(Reg.No:A1601PEFM099)**

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**DEPARTMENT OF PHYSICAL EDUCATION
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CHENNAI – 600 127**

AUGUST- 2019

DEDICATED TO
MY BELOVED
FATHER
MOTHER
AND
FAMILY MEMBERS

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T. GANESH KUMAR

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CHAPTER - I

INTRODUCTION

Sport has very prominent role in modern society. The world sport has a popular appeal among people of all ages and both sexes. Much of the attraction of sports comes from the wide variety of experience and feelings that result from participation joy, anguish, success, failure, exhaustion, pain, relief and a feeling of belonging sport can bring money, glory, status and good will, however, sport can also bring tragedy, grief and even death.

The study of Sport Science traditionally not only incorporates the areas of sport physiology, sport psychology, and sport biomechanics but also includes the other topics such as sport training and sport nutrition, sports technology, sport anthropometry, and performance analysis. Sport scientists and performance consultants are growing in demand and employment numbers, with the ever-increasing focus within the sporting world on achieving the best results possible. Through the study of science and sport, researchers have developed a greater understanding on how the human body reacts to exercise, training, different environments and many other stimuli.

1.1 SPORTS TRAINING

Training is the main component and the basic form of preparing the athlete for higher level of performance. It is asystematically

planned preparation with the help of the exercise which realizes the main factors of influencing athlete's progress. "Training is a systematic process of repetitive, progressive exercise or work involving learning process and acclimatization" (Daniel, 1985). "Sports training refer to the physical, technical, intellectual, psychological and moral preparation of an athlete by means of physical exercises" (Harre, 1982).

"Sports performance can be improved through Sports training. Like any other type of human performance, a sports performance is also a product of the total personality of the sports person. In generals the personality of a person reflects the aspects like physical, physiological, social and psychic traits. Therefore, apart from physical and physiological traits, the social and psychic trait of the sports person needs to be improved for achieving improvement in sports performances" (Singh, 1991).

1.2 BADMINTON

"The Game of Badminton is wonderful sport that requires eye-hand coordination, striking and quick movements and change of direction in pursuit of the shuttle cock. Badminton is a power game requiring quick and powerful movements to all directions to return the shuttle cock to the opponents' side of the court".

Badminton is an extremely demanding sport. At an elite level, players are often required top form at their limits of speed, agility, flexibility, endurance and strength. On top of all of this, players must

maintain a high state of concentration in order to meet the tactical as well as mental demands of dealing with their opponents. It is therefore essential that everyone involved with the modern game ought to be familiar with the fitness requirements of the game and must know how 'Badminton fitness' can be enhanced.

Badminton is a highly explosive sport, involving a unique movement technique over a relatively small court area (Hughes, 1995). It is an intermittent sport characterized by long bouts of high intensity exercise interspersed with rest periods (Faccini and DalMonte, 1996), and entails vigorous movement of both the lower and upper body musculature (Reilly *et al.*, 1990).

1.3 PHYSICAL AND PHYSIOLOGICAL REQUIREMENT OF THE SPORT

Badminton is a highly complex sport and this presents great challenges for players and coaches of all levels. An individual rally is a series of demanding movements performed using a movement pattern which is unique compared with any other sport. Rally length is often short (average for elite players is around 6-8 seconds) and, consequently, performed at very high intensity. However, players must also be prepared for long rallies. Rallies are interspersed with short rest Periods (typical duration around 15 seconds) which allow partial recovery from the previous rally, however, competitive matches may last at least 45 minutes. So, badminton is a combination of speed (anaerobic fitness) in rallies and endurance (aerobic fitness) to allow

sustained efforts and to promote recovery between rallies. Great strength, power, agility and flexibility are also required. All of these fitness components should form part of a player's fitness training. Additionally, the development of tactical and technical elements is, of course, also vital.

Junior players are required to have a good stroke production and physical fitness, as well as Physiological characteristics that will enable successful performance at the competitive level. The sport-specific technical skills in racket sports are predominant factors. The physical fitness of a player however, can be a decisive determinant of success during a tournament (Smekal et al., 2001).

According to Groppel and Roetert (1992) and Lei et al. (1993), the physical requirements of racquet sports demand efficiency in a number of fitness components. To be able to execute advanced strokes or compete effectively against progressively stronger opponents, a player would need to develop higher levels of the basic physical qualities, such as strength, power, muscular endurance, flexibility, coordination and agility.

Many sports require a generation of high forces and power outputs (Reilly et al., 1990). It is the muscles' ability to develop tension that forms the basis for all types of movement in sport (Omosegaard, 1996). Badminton at the highest level places a great

demand on leg and back strength, leg endurance as well as explosive power (Omosegaard, 1996).

1.3.1 STRENGTH

Muscular strength can be defined as the peak torque or force developed during a maximal voluntary contraction, under a given set of conditions (MacDougall et al., 1991). Badminton is a sport that is strength-related, rather than strength-limited in that the performance of a player is influenced by strength, not limited by it (Wrigley and Strauss, 2000).

1.3.2 LEG STRENGTH

Badminton at the highest level puts a great demand on leg strength and endurance (Omosegaard, 1996). The muscle strength during a movement varies during the range of movement due to muscular and mechanical conditions. Normally, the more a muscle is stretched, the more tension it can produce.

1.3.3 ARM STRENGTH

The important muscle groups of the arm for badminton are the rotator muscles of the shoulder joint, the under arm rotators, the arm extensors and the shoulder muscles which lead the upper arm forward-upwards, and backwards – upwards. The muscle strength of the arm is not an important requirement for badminton because the forces required in hitting the shuttle are not great (Reilly et al., 1990 and Omosegaard, 1996). This is due to the fact that the resistance to

the stroke of the movement is small (a racquet weighs approximately 100g and the shuttle is very light), and the smaller the resistance to movement, the less maximal muscle strength matters to the speed of the movement (Omosegaard, 1996). Speed strength, explosive strength and to some extent, maximum muscular strength are important for the arm muscles in badminton (Omosegaard, 1996).

1.3.4 POWER

Muscular power or explosive strength is one such element, and the ability to generate great amounts of power is recognized as a primary factor in athletic success (Beckenholdt and Mayhew, 1983). According to MacDougall et al. (1991), the relevance and relative importance of power in sport performance will vary according to the different requirements of the sport. Leg power is an important component in badminton in that it results in the player being able to move quickly and explosively to the shuttle in various directions and to jump high to play overhead strokes. Greater leg power results in a greater acceleration and faster speed when lifting off the floor when moving, or jumping to the shuttle. According to Omosegaard (1996), an explosive player will typically be able to jump high, change direction quickly and will generally appear to be swift and mobile on the badminton court.

1.3.5 MUSCULAR ENDURANCE

Muscular endurance is the ability of a muscle group to execute repeated contractions of submaximal resistance, over a period of

sufficient time to cause muscular fatigue, or to statically maintain a specific percentage of maximal voluntary contraction for a prolonged period of time (Luttgens et al., 1992 and ACSM, 1995). Endurance is involved to some extent in badminton due to the fact that ST fibres were found in the vastuslateralis muscles of badminton players. The repeated push-offs in the corners and playing center, places great demands on the dynamic endurance of the leg muscles of badminton players (Omosegaard, 1996).

1.3.6 SPEED

Speed is needed in badminton in moving to and from the shuttle. Speed on a badminton court is not only a question of being in good physical condition or following the right tactics, but is a combination of technique, tactics, physique and mental frame of mind (Omosegaard, 1996).

Running speed and agility are very important to the badminton player due to the need for speed variation, height and angle of approach to the shuttle. The ability to cover short distances quickly will also be of great advantage to the badminton player (Todd and Mahoney, 1995). Due to the nature of the game and the size of the court, it is important for the badminton player to reach his/her maximum speed as fast as possible.

1.3.7 FLEXIBILITY

Flexibility is an important, yet often neglected component of physical fitness (Heyward, 1998). Flexibility reflects the ability of the muscle-tendon units to elongate within the physical limitations imposed by the joint (MacDougall et al., 1991). A greater flexibility in badminton players would result in improved maximal strength, a greater ability to utilize the stretch-shorten cycles effectively, augmented efficiency and correct movement patterns throughout the required range of motion. It is for these reasons that flexibility is an important component of badminton.

1.3.8 AGILITY

Agility is the physical ability that enables a rapid and precise change of body position and direction (Johnson and Nelson, 1986), without a loss of balance (Sharkey, 1986). The whole body movement can be performed in the horizontal plane, or in the vertical plane (Draper and Lancaster, 2000). Agility is important to the badminton player due to the variation in the speed, height and angle of approach to the shuttle (Todd and Mahoney, 1995).

1.3.9 CARDIORESPIRATORY ENDURANCE

Cardiorespiratory endurance is described by ACSM (1995) as the ability to perform dynamic exercise involving large muscle groups at moderate to high intensity for prolonged periods of time. Simply stated, it is the ability of the body to take up, transport and utilize oxygen efficiently. A well conditioned heart and an efficient respiratory

system are essential for high levels of aerobic fitness, as it means that the systems will be able to adjust and recover quicker from the effects of exercise and work (Sharkey, 1997).

Elite badminton players require a combination of aerobic and anaerobic energy systems, and the involvement of these systems depend on the intensity of the rally and the duration of the match (Dewney & Brodie, 1980). Ninety percent of the energy demand is associated with the repeated bursts of intense, brief activity are met by the anaerobic processes, but it is the aerobic metabolism that supplies the energy to enable the player to last for the duration of the match. It has been estimated that 60 - 70% of the energy during badminton is derived aerobically and 30% anaerobically (Chin et al., 1995).

1.3.10 AEROBIC POWER

The term aerobic power or maximal oxygen consumption is synonymous with VO_{2max} , and is a component of cardiorespiratory endurance. It refers to the maximal amount of oxygen that can be transported and utilized by the body to produce energy aerobically while breathing air during heavy exercise. It reflects the capacity of the heart, lungs and blood in transporting oxygen to the working muscles as well as the utilization of oxygen by muscles during exercise (Heyward, 1998), and is a good indicator of aerobic fitness. Maximal oxygen consumption values obtained from research on top international badminton players are relatively high and vary from 55.7

– 73.0 mlO₂.kg⁻¹.min⁻¹ (Mikkelsen, 1979; Chin et al., 1995; Faccini and DalMonte, 1996; Omosegaard, 1996 and Majumdar et al., 1997).

1.3.11 ANAEROBIC POWER

There is a low contribution from the anaerobic system in supplying the necessary energy in badminton (Hughes, 1995). According to Chin et al. (1995), approximately 30% of the energy during badminton is derived anaerobically. Although the anaerobic energy contribution in badminton is low, there is a great demand on the player's ability to tolerate high anaerobic activity for short periods of time. This is due to the fact that the rallies during a game are a mixture of push-offs, direction changes, smashes, waiting for the shuttle, walks, runs and jumps. This type of activity activates the ATP-PC system.

1.4 TRAINING FOR BADMINTON

The type of training used by badminton players is generally related to the standard of the player. For younger players with less well-developed skill levels, most training is likely to be devoted to playing games. With higher skill levels comes greater dedication to the game and increased use of many potential types of training that will help competitive performance. Badminton training can be initially categorized into on court and off-court work. On court work would mean training with badminton movements with a racket and usually (although not always) with a shuttle. Off-court work is usually additional work that has the aim of enhancing some particular aspect of fitness.

1.5 SPECIFIC FITNESS TRAINING

Training needs to be varied in order to enhance both physical and physiological development. Apart from general physical requirements of a badminton player specific fitness requirement has to be planned to improve upon the game. Technically, if a certain skill is developed using a range of drills, then there is a greater likelihood that it can be applied to new, unexpected situations. If a player needs to increase movement speed, then that needs to be achieved in many varied circumstances on and off the court. Clearly on-court speed is vital for the sport but general development of speed off the court will also transfer onto the court if movement technique is good.

Specific area of fitness also includes playing games 'Shadow play' (i.e., Badminton without a shuttle) Multi-feed, Conditioned games, Conditioned drills etc. The purpose of all these trainings was basically to bring the player's game to the next level and each training involves badminton drills. A badminton drill will normally involve two people. One will of course perform the drills whilst another person will feed the shuttle. In these trainings, shadow strokes are combined with actual strokes to increase skills and shot accuracy.

1.6 NEUROMUSCULAR TRAINING

Neuromuscular training has been defined as multi-intervention programs that combine balance, strength, plyometrics, agility, and sport-specific exercises (Coughlan and Caulfield, 2007).

The neuromuscular training improves the nervous system's ability to generate a fast and optimal muscle firing pattern, which increases dynamic joint stability, decreases joint forces and relearns movement patterns and skills. The concepts include teaching athlete the movement pattern related to therapeutic exercise, thus prepare them to return to their sports activity. The basis of neuromuscular training involves three stage models consisting of cognitive, associative and autonomous stage (Ellenbecker, 1995).

1.7 REASON FOR SELECTION OF TOPIC

Junior players are required to have a good physical fitness, as well as physiological profiling and stroke production that will enable successful performance at the competitive level. The aims and objective of the present study was to examine the player's physical fitness, physiological responses and simultaneously to measure the skills related variables among state level male junior badminton player. It is important to ascertain the most efficacious method for enhancing fitness performance and also to bring the player to the next level and reduce the fatigue. Further, not much research has been completed on the physiological aspects of badminton. This research proposes to examine the impact of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

1.8 STATEMENT OF THE PROBLEM

The present study was to examine the impact of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

1.9 HYPOTHESES

The following are the hypotheses set for the present investigation.

1. It was hypothesized that there would be a significant improvement on selected physical physiological and skill related variables due to specific skill training among state level male junior badminton players.
2. It was hypothesized that there would be a significant improvement on selected physical physiological and skill related variables due to neuromuscular training among state level male junior badminton players.
3. It was hypothesized that specific skill training would be better in improving skill related variables of state level male junior badminton players than neuromuscular training.
4. It was hypothesized that neuromuscular training would be better in improving physical and physiological variables of state level male junior badminton players than specific skill training.

1.10 SIGNIFICANCE OF THE STUDY

1. The result of the study would be helpful in mounting specific skill training and neuromuscular training for state level junior badminton players.
2. It would be of enormous help for the coached and fitness trainers to opt for the specific skill training and neuromuscular training frequency for their players.
3. The finding of this study may add knowledge in the area of training methodology and exercise recommendation.
4. This information helps health professionals to select and perform the most appropriate test and testing protocols for the benefit of their clients.

1.11 DELIMITATIONS

1. Thirty state level junior male badminton players were selected at randomly in the age group of 16 and 18 years.
2. The entire subject was selected from Chennai city only.
3. The criterion variables selected for the study were

Dependent Variables

Physical Fitness Variables

1. Speed
2. Agility
3. Flexibility
4. Arm strength
5. Leg explosive power

Physiological Variables

1. Anaerobic Power
2. Maximal oxygen uptake

Skill Related Variables

1. Short Service
2. Long Service
3. Forehand Clear
4. Backhand Clear
5. Volleying Ability

Independent Variable

1. Experimental group I - Specific Skill Training
2. Experimental group II -Neuromuscular Training
3. Control group IV - No training

1.12 LIMITATIONS

1. The heterogeneous characters of the subjects in hereditary and environmental factors, lifestyle and physiological stress and other factors that affect the metabolic functions were recognized as limitation.
2. All the specific skill and neuromuscular training programme was explained by the research scholar, so that the times taken by the subjects to respond and recognized as limitations of the study.

3. The uncontrollable changes in climatic conditions such as atmosphere temperature, humidity and other metro logical factors during the test were considered as limitations.

1.13 DEFINITION AND EXPLANATION OF THE TERMS

1.13.1 SPEED

According to Corbin, (2007), speed is an ability to perform a movement or cover a distance in a short time.

1.13.2 AGILITY

According to Elizabeth, (2007) agility is the ability to move and change direction and position of the body quickly and effectively while under control.

1.13.3 ARM STRENGTH

The forearms are the muscles that provide essential grip strength, keep them in top condition is what make us strong to finish in any sports or activity involving our arm.

1.13.4 FLEXIBILITY

A person's flexibility refers to the ability of his joints to move through a full range of motion (Paige, 2008).

1.13.5 LEG EXPLOSIVE POWER

Measuring the distance between a person's standing reach and the height he or she can jump and reach has been proposed as a test of leg explosive power.

1.13.6 MAXIMAL OXYGEN UPTAKE

VO₂ max is the maximal oxygen uptake or the maximum volume of oxygen that can be utilized in one minute during maximal or exhaustive exercise. It is measured as milliliters of oxygen used in one minute per kilogram of body weight **(Elizabeth Quinn, 2007)**.

1.13.7 ANAEROBIC POWER

Anaerobic power is energy that is stored in muscles and that can be accessed without the use of oxygen. There are two systems that utilize this type of power, the phosphogen system and the lactic acid system. Human beings use this form of energy in short bursts that cannot be sustained for longer than about two minutes **(Fox, 2014)**.

1.13.8 JUNIOR

Junior refers to male badminton players who are 18 years old or younger.

CHAPTER II

REVIEW OF RELATED LITERATURE

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area. It gives an overview of what has been said, who the key writers are, what are the prevailing theories and hypotheses, what questions are being asked, and what methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other findings. The present reviews are based upon the available literature in respect to the study under investigation and therefore confined to the studies to which the investigator has accessed. All the relevant literature thus obtained by the researcher has been presented in this chapter to furnish necessary background material to evaluate the significance of the study.

The research scholar has made every possible effort to go through the literatures related to the problem in the plyometric and functional core training wherever available. The scholar has gleaned through almost every source like research quarterly, journals of various kinds, periodicals, encyclopedias, relevant book and e-resources. However, the

scholar has also gone through the literatures of allied studies to collect the necessary information for making a proper shape of the study.

The reviews of the literature have been classified under the following headings.

1. Studies on Physical Fitness Variables
2. Studies on Physiological Variables
3. Studies on Skill Related Variables

2.1 STUDIES ON PHYSICAL FITNESS VARIABLES

Mert Aydogmuş et al., (2015) studied the effect of badminton-specific training and badminton match on aerobic fitness. The results of the study shows that there were significant differences between pre-test and post-test in both badminton specific training and match group. However, there were no significant differences in shuttle run between badminton-specific training and match groups. In the present study, both badminton-specific training and badminton match six times per week for 12 weeks increased aerobic fitness level.

Eng Hoe Wee, et al., (2017) investigated the effects of high intensity intermittent badminton multi-shuttle feeding training on aerobic and anaerobic capacity, leg strength qualities and agility. Pre-test results showed insignificant differences between two groups implying that they started equal in terms of six variables. Similarly, post-test revealed non-significant results for all the six variables. However, the comparison of pre-test and post-test mean scores showed

significant improvements in VO₂max, mean power, leg reactive strength and agility except peak power and jump height in experimental group with control group showed no improvement in all parameters.

Srinivasan and Sathishkumar, (2016) studied the effect of ladder training on selected physical fitness variables on school volleyball players. It was concluded that there is a significant improvement due to ladder training on agility, explosive power school volleyball players.

Minkai Dong et al., (2018) compared the Shuttle Run (SR) with Reactive Initiation Training (RIT) to determine which one is more effective for improving on-court agility of novice badminton players. Both training methods shortened the mean running time, however, only Reactive Initiation Training (RIT) additionally reduced the initiation time and its proportion on those time-consuming positions in the occluded condition. Reactive Initiation Training (RIT) is more effective than Shuttle Run (SR) to improve the on-court agility of novice badminton players.

Fernandez-Fernandez, et al.,(2018) examined the effects of a 5-week neuromuscular training (NMT) implemented before or after a tennis session in pre pubertal players on selected components of physical fitness. the results showed that the before tennis-specific training group achieved positive effects from pretest to posttest measures in speed, modified 5-0-5 agility test; countermovement jump,

overhead medicine ball throw; and serve velocity, whereas trivial or negative effects were reported for the after tennis-specific training group. The inclusion of an neuromuscular training (NMT) session before the regular tennis training led to positive effects from pretest to posttest measures in performance-related variables (i.e., jump, sprint, change of direction capacity, as well as upper-body power), whereas conducting the same exercise sessions after the regular tennis training was not accompanied by the same improvements.

2.2 STUDIES ON PHYSIOLOGICAL VARIABLES

Minakshi Pathak (2015) studied the effects of Badminton Specific Circuit Training on Selected Physiological Variables of Badminton Players. The results of the study proved that there was a significant difference found in relation to positive breath holding capacity which might be due to the participating in rigorous cardiovascular activity in the form of Circuit Training. Exercise is a great way to increase lung capacities, which also include the Positive Breath Holding Capacity. So it can be concluded that Badminton Specific Circuit Training can be the contributing factor for the coaches to plan appropriate loads and maximizing the performance of Badminton players.

Iturricastillo, et al (2018) analyzed the changes of physical performance and physiological responses during a high-intensity training task in wheelchair basketball (WB) players. The results of the study shows that there was a 1.10% decline in performance in both 5-

and 20-m sprints, 1.82% decline in 5-m sled towing, and 2.68% decline in 20-m sled towing between pre- and post-SSG. As in physical performance results, significant differences were observed between pre and post in physiological markers, with increasing tympanic temperature and blood lactate concentrations after small sided game. The small sided game produced a decrease in sprint and sled towing performance after 16 min of intense exercise. Moreover, the decrease in physical performance was accompanied with an increase in physiological responses. These neuromuscular responses could be similar in the real game; thus, coaching staff could benefit from this information when changing bench players.

Zemkova and Hamar, (2018) studied the neuromuscular training in young athletes improves performance and decreases the risk of injuries during sports activities. These effects are primarily ascribed to the enhancement of muscle strength and power but also balance, speed and agility. However, most studies have failed to demonstrate significant improvement in these abilities. This is probably due to the fact that traditional tests do not reflect training methods (e.g., plyometric training vs. isometric or isokinetic strength testing, dynamic balance training vs. static balance testing). The protocols utilized in laboratories only partially fulfill the current needs for testing under sport-specific conditions. Moreover, laboratory testing usually requires skilled staff and a well equipped and costly infrastructure. Nevertheless, experience demonstrates that high-technology and expensive testing is

not the only way to proceed. A number of physical fitness field tests are available today. However, the low reliability and limited number of parameters retrieved from simple equipment used also limit their application in competitive sports. Thus, there is a need to develop and validate a functional assessment platform based on portable computerized systems. Variables obtained should be directly linked to specific features of particular sports and capture their complexity. This is essential for revealing weak and strong components of athlete performance and design of individually-tailored exercise programs. Therefore, identifying the drawbacks associated with the assessment of athlete performance under sport-specific conditions would provide a basis for the formation of an innovative approach to their long-term systematic testing. Their study aims was (i) to review the testing methods used for the evaluation of the effect of neuromuscular training on sport-specific performance in young athletes, (ii) to introduce stages within the Sport Long life Diagnostic Model, and (iii) to propose future research in this topic. Analysis of the literature identified gaps in the current standard testing methods in terms of their low sensitivity in discriminating between athletes of varied ages and performance levels, in sufficient tailoring to athlete performance level and individual needs, a lack of specificity to the requirements of particular sports and also in revealing the effect of training. In order to partly fill in these gaps, the Sport Long life Diagnostic Model was proposed.

Bisschoff, Coetzee, & Esco., (2018) studied whether pre-match, in-match, resting and post-match heart rate variability (HRV) as well as resting and post-match heart rate recovery (HRR) can serve as significant predictors of male, elite, African, singles badminton players' performance levels. The results showed that log transformed low frequency to high frequency ratio and peak very low frequency power (VLF power (Hz)), were significantly ($p < .05$) related to group allocation of successful and less successful badminton players. Overall model fit was good and 75% of players could be classified into their original groups by making use of the HRV-based logistic regression formulas. Furthermore, all models had a large effect in predicting player classification, although only the pre- and in-match models emerged as being useful. Short-term frequency domain-related HRV variables are related to badminton match performances and should be considered when measuring HRV in sport and exercise settings.

Barnamehei, et al (2012) compared the muscle activations and synergies in badminton forehand overhead smash (BFOS) between elite and non-elite players to clarify how the central nervous system (CNS) controls neuromuscular synergy and activation to generate complex overhead movements. Results proved that muscles synergies could sufficiently delineate the found electromyography signals for elite and nonelite players. Individual muscle patterns were moderately to highly similar between elite and non-elite groups. In addition, high similarities between groups were found for the shape of synergy activation

coefficients. These results indicate that the synergistic organization of muscle coordination during badminton forehand overhead smash is not profoundly affected by expertise.

Duncan, et al., (2017) examined the effects of changes in physiological and psychological arousal on badminton short-serve performance in competitive and practice climates. The results of the study indicated that better short-serve performance was evident in practice compared to competition ($P = .034$). RPE values were significantly higher in the competition condition compared to practice ($P = .007$). Cognitive anxiety intensity was significantly lower post-exercise in the practice condition compared to competition ($P = .001$). Cognitive anxiety direction showed greater debilitation post-exercise in the competition condition compared to practice ($P = .01$). Somatic anxiety intensity increased from pre-, to mid- to post-exercise ($P = .001$) irrespective of condition. This study suggests that badminton serve performance is negatively affected when physiological arousal, via badminton-specific exercise, and cognitive anxiety, via perceived competition, are high.

Hassan, (2017) examined the effects of core stability training on dynamic balance and smash stroke velocity and accuracy performance. The results of the study indicated that significant improvement was obtained only in the training group for core muscle endurance, total reached distance of three directions in star excursion balance test and smashing velocity and accuracy variables ($p < 0.05$). Consequently,

eight weeks core stability training provides an improvement for maintained optimum lower limbs dynamic balance and increased the performance level of smash stroke in young badminton players.

Nadzalan, et al (2017) compared the effects of step versus jump forward lunge training on muscle architecture among badminton players. The results of the study showed both treatment groups had their muscle architectures significantly changed in the post-test compared to the pre-test. Jump forward lunge had significantly greater improvement in muscle thickness of vastuslateralis, vastusmedialis and rectus femoris and also pennation angle of vastusmedialis compared to step jump forward lunge. Overall, Jump forward lunge was found to be superior in altering muscle architectures of the lower body compared to step jump forward lunge training.

Yuksel, & Akin, (2017) examined the effects of core training on dynamic balance ability of high level Badminton players. The results of the study showed that eight weeks core training increased dynamic balance ability of experimental group, not for control group participants. Core training has an effect on dynamic balance in high level badminton players and it should be used for improving balance ability of badminton players.

Lin, (2014) investigated the changes in knee extensor neuromuscular function and muscle soreness after a simulated 1-h badminton singles match in relation to the number of lunges performed

in the match. The number of lunges performed by each player in a game was obtained from video analysis. Heart rate (HR) and core body temperature were recorded during the matches, and blood lactate (BL) was measured before and immediately post match. Both femoral nerve and muscle electrical stimulations were used in the present study. It was concluded that both central and peripheral factors contributed to alterations in neuromuscular fatigue and that muscle damage was moderate after the singles matches in the game intensity and physiological characteristics were close to those in competitive tournaments.

Blomqvist et al., (2000) examined the differences in skill, game performance and game understanding in expert (n=12) and novice (n=14) youth badminton players (13-14 years). The results clearly showed that skill, game play and cognitive components all differentiated experts from novices. Experts exhibited significantly more sport skill, played more effective shots and understood the game situations better when compared to novices. Based on the findings it could be suggested that all these qualities must be taken into account when teaching/coaching games in order to increase competence, interest and enjoyment in games playing.

Alonso & Dias Johnson, (2011) examined the physiological effect of periodized specific strength training on young Swedish division 2 basketball players. The control group results decreased in all test parameters except in Jump Squad and T-test although the increases in

the test results were not found to be significant. The conclusion to the study was that an intervention of specific training yields positive results in young basketball players. The results garnered from the intervention verify that this type of training may influence in season progress as well as being a time effective training tool for strength and conditioning specialists.

Luiz França Bahia Loureiro (2012) investigated whether expert badminton players would present better indices of neuromuscular performance than intermediate level badminton players in a target-pointing task. The results revealed no effect of group on movement time and radial error, but revealed that reaction time was shorter for EPG than for IPG. Moreover, reaction time was lower in simple reaction time than in choice reaction time condition and reaction time and movement time was lower when the target was ipsilaterally presented and during simple reaction time condition. The shorter RT presented by expert badminton players when compared to intermediate level players could indicate that RT could be a key neuromuscular variable to distinguish expert from non-expert badminton players. Finally, although the experimental protocol does not integrally represent the actions performed during the game, it is a progress when compared to the tests commonly used to investigate the response time (RT and MT) in athletes, and should be used to assess those neuromuscular variables in athletes of sports that use the upper extremity.

Dong et al., (2018), compared SR with RIT to determine which one is more effective for improving on-court agility of novice badminton players. 20 novice badminton players were split in half to receive either RIT or SR on court for five days. Before and after training, participants were assessed on their ability to intercept the shuttlecocks randomly thrown by a coach to six corners of the court with and without visual occlusion of the coach. All trials of interception were recorded for video analysis of initiation time, running time and total time. The mean total times were greater with visual occlusion and varied systematically with the position of interception. Both training methods shortened the mean running time, however, only RIT additionally reduced the initiation time and its proportion on those time-consuming positions in the occluded condition. RIT is more effective than SR to improve the on-court agility of novice badminton players.

Maloney, (2018) Lunge performance is integral to performance in the sport of badminton. The strength and conditioning coach to appropriately condition the lunge pattern, it is important that the unique demands of the badminton lunge are well understood. This article will consider the kinetics, kinematics, and different variations of the badminton lunge, identify the potential determinants of lunge performance, and highlight some of the key training considerations. It is proposed that programs designed to develop the lunge should ultimately consider 4 components: stability, strength, power, and specific endurance.

Phomsoupha, Berger, & Laffaye, (2018) investigated (a) to develop a new sport-specific, repeated-sprint ability test involving 4 changes of direction, namely, the multiple repeated sprint ability test for badminton players; (b) to determine its validity by comparing the results of 5 different skill levels; and (c) to assess the link between the new test and neuromuscular lower limb and physiological variables. The results showed that the multiple repeated sprint badminton ability test is valid, because it differentiates between the 5 skill levels for BT, MT and FI and offers a reliable method for testing badminton players, with no differences between the sessions. Moreover, the link between MT and neuromuscular variables, such as jump height in squats and countermovement and with VO₂max reveals that this test uses a combination of the anaerobic and aerobic systems; thus, it can be used by trainers either to improve movement ability or increase these physical qualities.

Zemkova, & Hamar, (2018), Neuromuscular training in young athletes improves performance and decreases the risk of injuries during sports activities. These effects are primarily ascribed to the enhancement of muscle strength and power but also balance, speed and agility. However, most studies have failed to demonstrate significant improvement in these abilities. This is probably due to the fact that traditional tests do not reflect training methods (e.g., plyometric training vs. isometric or isokinetic strength testing, dynamic balance training vs. static balance testing). The protocols utilized in

laboratories only partially fulfil the current needs for testing under sport-specific conditions. Moreover, laboratory testing usually requires skilled staff and a well equipped and costly infrastructure. Nevertheless, experience demonstrates that high-technology and expensive testing is not the only way to proceed. A number of physical fitness field tests are available today. However, the low reliability and limited number of parameters retrieved from simple equipment used also limit their application in competitive sports. Thus, there is a need to develop and validate a functional assessment platform based on portable computerized systems. Variables obtained should be directly linked to specific features of particular sports and capture their complexity. This is essential for revealing weak and strong components of athlete performance and design of individually-tailored exercise programs. Therefore, identifying the drawbacks associated with the assessment of athlete performance under sport-specific conditions would provide a basis for the formation of an innovative approach to their long-term systematic testing. This study aims (i) to review the testing methods used for the evaluation of the effect of neuromuscular training on sport-specific performance in young athletes, (ii) to introduce stages within the Sport Long life Diagnostic Model, and (iii) to propose future research in this topic. Analysis of the literature identified gaps in the current standard testing methods in terms of their low sensitivity in discriminating between athletes of varied ages and performance levels, insufficient tailoring to athlete performance level and individual needs, a lack of specificity to the requirements of particular sports and also in

revealing the effect of training. In order to partly fill in these gaps, the Sport Long life Diagnostic Model was proposed.

Duncan, Chan, Clarke, Cox, & Smith, (2017) examined the effects of changes in physiological and psychological arousal on badminton short-serve performance in competitive and practice climates. Twenty competitive badminton players (10 males and 10 females) volunteered to participate in the study following ethics approval. After familiarisation, badminton short-serve performance was measured at rest, mid-way through and at the end of a badminton-specific exercise protocol in two conditions; competition vs. practice. Ratings of cognitive and somatic anxiety were assessed at three time points prior to badminton short-serve performance using the Mental Readiness Form 3. Heart rate and rating of perceived exertion (RPE) were assessed during the exercise protocol. Results indicated that better short-serve performance was evident in practice compared to competition ($P=.034$). RPE values were significantly higher in the competition condition compared to practice ($P=.007$). Cognitive anxiety intensity was significantly lower post-exercise in the practice condition compared to competition ($P=.001$). Cognitive anxiety direction showed greater debilitation post-exercise in the competition condition compared to practice ($P=.01$). Somatic anxiety intensity increased from pre-, to mid- to post-exercise ($P=.001$) irrespective of condition. This study suggests that badminton serve performance is negatively affected when

physiological arousal, via badminton-specific exercise, and cognitive anxiety, via perceived competition, are high.

Callow, Hardy, & Hall, (2001) examined the effects of a Motivational General-Mastery imagery intervention on the sport confidence of 4 high-level junior badminton players. Sport confidence data were collected once a week for 21 weeks prior to international and county matches. The imagery intervention consisted of six imagery sessions (two per week for 3 weeks) and was administered using a multiple-baseline design with interventions commencing at Weeks 5, 7, 9, and 11 for Participants 1, 2, 3, and 4, respectively. Results of visual inspection and Binomial tests suggested significant increases in sport confidence for Participants 1 and 2, a significant decrease in sport confidence for Participant 3, and a delayed increase in sport confidence for Participant 4. The results are discussed in terms of the implications of using mastery imagery and the usefulness of multiple-baseline designs for furthering imagery research.

Hastie, Sinelnikov, & Guarino, (2009) examined the development of skill competence and tactical knowledge of 41 eighth-grade students (mean age 13.6 years) as they completed a season of badminton conducted following the features of Sport Education. Using data from students' performance on badminton skills tests, their competence in game play, and their tactical knowledge, it was determined that these students made significant improvements in their ability to not only control the shuttle, but also to hit it more

aggressively. This resulted in improvements in both the selection (what shot to make) and execution (ability to produce the desired shot) dimensions of their game play. In addition, the students demonstrated significant improvements in their ability to select tactical solutions and make arguments for those decisions when watching videotaped performances of badminton games. The key explanation for the development of competence in this setting was that the structure of the Sport Education season allowed for significant practice opportunities, and that the authenticity and consequential nature of the game play helped move all but weak novice students from a more cooperative version of net-game play to one where tactical decision making and execution was valued.

Sakurai, & Ohtsuki, (2000) established the temporal-spatial relationship between muscle activity and the smash stroke of skilled badminton players and to assess performance accuracy using the ellipse of constant distance. We recorded the surface electromyographic (EMG) activity of selected superficial muscles of the stroking arm and shoulder - flexor carpi ulnaris, extensor carpi radialis, triceps brachii (lateral head), biceps brachii and trapezius (upper) - during the badminton smash. In the first part of the study, we examined the characteristics of muscle function and performance accuracy of skilled and unskilled individuals during the badminton smash. Five well trained badminton players and five students with no experience of badminton were asked to smash a shuttle as hard as they could

towards a vertical square target 4 m away, repeating the stroke 30 times. In general, the skilled players showed a more constant time from peak electromyographic amplitude to impact. Immediately after impact, the electromyographic activity of the triceps brachii and flexor carpi radialis of the skilled players decreased; in the unskilled participants, however, it continued until well after impact. The area of the ellipse of constant distance and the off-target distance, which were used as indices of performance accuracy, were smaller for the skilled than for the unskilled participants. In the second part of the study, one skilled and one unskilled participant performed 100 trials a day for 6 days. The time from peak electromyographic amplitude to impact in the extensor carpi radialis and flexor carpi ulnaris was more variable in the unskilled than in the skilled participant even after 6 days of practice, but the proximal muscles of the unskilled participant had a similar pattern of activity to that of the skilled player. Thus, controlling the distal muscles appears to be important for achieving accurate performance of the smash in badminton.

Jin, et al (2011), studied the ability to predict the trajectory of a ball based on the opponent's body kinematics has been shown to be critical to high-performing athletes in many sports. However, little is known about the neural correlates underlying such superior ability in action anticipation. The present event-related potential study compared brain responses from professional badminton players and non-player controls when they watched video clips of badminton games and

predicted a ball's landing position. Replicating literature findings, the players made significantly more accurate judgments than the controls and showed better action anticipation. Correspondingly, they showed enlarged amplitudes of two ERP components, a P300 peaking around 350 ms post-stimulus with a parietal scalp distribution and a P2 peaking around 250 ms with a posterior-occipital distribution. The P300 effect was interpreted to reflect primed access and/or directing of attention to game-related memory representations in the players facilitating their online judgment of related actions. The P2 effect was suggested to reflect some generic learning effects. The results identify clear neural responses that differentiate between different levels of action anticipation associated with sports expertise.

Pearce, et al (2000) stated that relatively rapid changes in functional representation may occur in the human sensorimotor cortex in short-term motor-learning studies, there have been few studies of changes in organisation of the corticomotor system associated with the long-term acquisition of motor skills. In the present study, we have used transcranial magnetic stimulation (TMS) to investigate the corticomotor projection to the hand in a group of elite racquet players, who have developed and maintained a high level of skill over a period of many years, and have compared the findings with those in a group of social players and a group of non-playing control subjects. Increased motor-evoked-potential (MEP) amplitudes and shifts in the cortical motor maps for the playing hand were found in all of the elite players

and cortical motor thresholds were reduced in some players, whereas in the social players all parameters were within the normal range. The findings in the elite players are interpreted as being indications of a process of functional reorganisation with the motor cortex or corticomotor pathway that are associated with the acquisition and retention of complex motor skills.

Phomsoupha, Berger, & Laffaye, (2018) examined (a) to develop a new sport-specific, repeated-sprint ability test involving 4 changes of direction, namely, the multiple repeated sprint ability (MRSAB) test for badminton players; (b) to determine its validity by comparing the results of 5 different skill levels; and (c) to assess the link between the new test and neuromuscular lower limb and physiological variables. For this purpose, 42 participants were separated into 5 groups to perform the MRSAB test at the same time of day, on 2 occasions, separated by at least 48 hours. The MRSAB test consisted of 2 repetitions of 4 movements (4×3 m) separated by 30 seconds of passive recovery. This pattern was repeated 10 times. The best time (BT), mean time (MT), and fatigue index (FI) were measured. Heart rate and blood lactate concentration were also recorded to determine the participants' physiological responses to the test. The results show that the MRSAB test is valid, because it differentiates between the 5 skill levels for BT, MT and FI and offers a reliable method (intraclass correlation coefficient = 0.95 for BT and MT) for testing badminton players, with no differences between the sessions ($p > 0.05$). Moreover, the link between

MT and neuromuscular variables, such as jump height in squats and counter movements ($r = -0.55$ and -0.60 , respectively) and with V [Combining Dot Above] O₂max ($r = -0.92$) reveals that this test uses a combination of the anaerobic and aerobic systems; thus, it can be used by trainers either to improve movement ability or increase these physical qualities.

2.3 STUDIES ON SKILL RELATED VARIABLES

Mazin Ahmad and Sarahang Abdullah, (2014) investigated whether distributor and intensive exercises conferred any greater alterations in accuracy of high and low serve skills performance. Sixteen badminton players completed a set of performance tests in the week before and after a 4-week training period. Performance tests consisted of high and low serve test and accuracy of serve test. After pretesting, pair matched participants were randomly assigned in two experiment groups. First experiment group undertook distributor style training and second experiment group undertook intensive style training. Results of current study revealed that the maximum (mean (SD)) high serve, low serve, high serve performance, and low serve performance tests recorded during the tests were 6(0.32), 7(0.64), 4(0.45), 3(0.55) respectively. Mean (SD) values for intensive group at the study variables after training were 13(1.42), 12(0.42), 7(0.43), 6(0.46) respectively. Researchers concluded the intensive exercise group reported improvements in all tests better than distributor exercise group. Then, different training styles appear to lead

to worthwhile growths in high and low and serving accuracy test with badminton players.

Ibrahim Hamed Ibrahim Hassan, (2017) examined the effects of core stability training on dynamic balance and smash stroke velocity and accuracy performance. Twenty badminton players under 19 years were divided into two groups, core training group ($n = 10$) and control group ($n = 10$). Core stability training group completed 8 weeks training programme, while control group did only their badminton traditional training. The effectiveness of core stability training intervention was assessed by performing core stability tests with four positions, dynamic balance test and forehand smash stroke performance test. Significant improvement was obtained only in the training group for core muscle endurance, total reached distance of three directions in star excursion balance test and smashing velocity and accuracy variables ($p < 0.05$). Consequently, eight weeks core stability training provides an improvement for maintained optimum lower limbs dynamic balance and increased the performance level of smash stroke in young badminton players.

Sakurai, and Ohtsuki, (2000) examined the characteristics of muscle function and performance accuracy of skilled and unskilled individuals during the badminton smash. Five well trained badminton players and five students with no experience of badminton were asked to smash a shuttle as hard as they could towards a vertical square target 4 m away, repeating the stroke 30 times. In general, the skilled

players showed a more constant time from peak electromyographic amplitude to impact. Immediately after impact, the electromyographic activity of the triceps brachii and flexor carpi radialis of the skilled players decreased; in the unskilled participants, however, it continued until well after impact. The area of the ellipse of constant distance and the off-target distance, which were used as indices of performance accuracy, were smaller for the skilled than for the unskilled participants. In the second part of the study, one skilled and one unskilled participant performed 100 trials a day for 6 days. The time from peak electromyographic amplitude to impact in the extensor carpi radialis and flexor carpi ulnaris was more variable in the unskilled than in the skilled participant even after 6 days of practice, but the proximal muscles of the unskilled participant had a similar pattern of activity to that of the skilled player. Thus, controlling the distal muscles appears to be important for achieving accurate performance of the smash in badminton.

Nadzalan et al., (2018) evaluated the effects of step versus jump forward lunge training on badminton specific physical abilities. Thirty recreationally active badminton players (mean age = 22.07 ± 1.39 years old) were recruited and divided into three groups; step forward lunge (SFL), jump forward lunge (JFL) and control group (CG). Lunge one repetition maximum (1RM), lunge relative 1RM, vertical jump, standing broad jump and change of direction (COD) t-test were tested pre- and post- eight weeks of training intervention. Results

showed both treatment groups (SFL and JFL) had improved significantly in all tests. JFL was shown to have significantly greater improvement in lunge 1RM, lunge relative 1RM, vertical jump, and standing broad jump compared to SFL. Results demonstrated the superiority of jump forward lunge (JFL) training compared to step forward lunge (SFL) in enhancing badminton specific physical abilities. However practitioners still advised to start their program with step forward lunge (SFL) and proceed to of jump forward lunge (JFL) after certain period of time. This is due to high contraction velocity nature of jump forward lunge (JFL) which might have higher risk of injury if performed without sound strength basis.

Acharya and James (2004) investigated proprioceptive training as a measure of skill improvement among novice badminton players. The test variables incorporated during the experiment were skills test in Badminton (Forehand Overhead Straight Clear, Forehand Straight Drop & Forehand under Arm straight Lob) that was performed in combination with each other in drill form (designed by the investigators). Single Leg Stance Balance Test (Bohannon 1984) and assessment in biodex balance system for limits of stability for both comprehensive and comparative (Bilateral) report in eyes open condition. One-way analysis of variance and t-test showed significant improvement in the skills of clear & lob, and in single leg balance test & in comparative balance test on Biodex Balance System for experimental

group respectively. Proprioceptive training is not only for rehabilitation but also for improvement of skills and sport performance.

Blackburn et al., (2000) determined whether proprioception or muscular strength is the dominant factor in balance and joint stability and define what type of ankle rehabilitation is most effective for these purposes. Thirty-two healthy volunteers free of head injury, dominant leg injury, and vestibular deficits. Subjects were divided into control, strength-training, proprioceptive-training, and strength-proprioception combination training groups. Balance was assessed before and after 6-week training programs. Subjects showed no improvement for static balance but improved significantly for semi dynamic ($P = .038$) and dynamic ($P = .002$) balance. No significant differences were observed between groups. Enhancement of proprioception and muscular strength are equally effective in promoting joint stability and balance maintenance. In addition, no 1 type of training program is superior to another for these purposes.

Madsen (2017) Studied the badminton fitness program consists of a combination of badminton specific resistance exercises and match play. Before and after the training intervention students were tested in a series of badminton specific and non-specific performance tests and anthropometrics were measured. The badminton fitness program reduced fat mass and fat percentage among the students whereas no difference was observed after the 8-week standard high school badminton program. Badminton specific endurance improved after both

interventions whereas badminton specific speed only improved after the badminton fitness program. The present study demonstrated that 8-weeks of badminton specific fitness training can improve body composition and badminton specific performance more than standard badminton high school training in high school students.

Frohlich, Felder & Reuter, (2014) investigated the effects of an 8-week periodized PT program on jumping high and power among male and female junior badminton players, using high-impact bilateral plyometric exercises. Starting and finishing with the biomechanical diagnostics of the squat jump (SJ), counter movement jump (CMJ), and drop jump (DJ) on force plates, kinematic analysis of forehand overhead smashes, anthropometric data as well as force data for pre- and posttest were analyzed. Looking at the plyometric strength parameters of the squat jump and the floor reaction-time of the drop jump, the positive effect of the 8-week PT in junior badminton players is significant. Consequently, this form of training is essential for the development of junior and top-level badminton players. Moreover, the study has shown that the contact of the overhead smash cannot be increased by improving plyometric strength training ($P>0.05$). Therefore, the focus must be on technical training. Consequently, it is considered to be important to include short-term PT in in-season preparation in order to improve complex badminton-specific dynamic performance (smash-jumping).

2.4 SUMMARY OF RELATED LITERATURE

The investigator has reviewed related literature on specific skill training and neuromuscular training on selected physical fitness, physiological and skill related variables among state level junior male badminton players. Through the review of related literature the investigator found about what has been done so far and what can be done in this research. Reviews proved that was further scope for research in finding out effect of specific skill training and neuromuscular on selected physical fitness, physiological and skill related variables among state level junior male badminton players.

CHAPTER - III

METHODOLOGY

Research methodology involved the systematic procedure by which researcher starts from the initial identification of the problem to its final conclusions. The rule of the methodology is to carry on the research work in a scientific and valid manner. The purpose of the study was to determine the impact of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

This chapter provides an overview of the method used for the research study selection of subject, selection of variables, experimental design, pilot study, selection of test, reliability of data, administration of test, collection of data, and statistical techniques employed are discussed here.

3.1 SELECTION OF THE SUBJECT

To achieve the purpose of the study, thirty (N=30) state level junior male badminton players are going to select randomly in the age group of 16 and 18 years Chennai. They will be assigned into three group's namely experimental group I (specific skill training), experimental group II (neuromuscular training) and group III acted as Control Group. Experimental groups underwent training for a period of 12 weeks.

3.2 SELECTION OF VARIABLES

This study was to find out the effect of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

The following variables were selected for this study,

3.2.1 DEPENDENT VARIABLE

Physical Fitness Variables

1. Speed
2. Agility
3. Flexibility
4. Arm strength
5. Leg explosive power

Physiological Variables

1. Anaerobic Power
2. Maximal oxygen uptake

Skill Related Variables

1. Short Service
2. Long Service
3. Forehand Clear
4. Backhand Clear
5. Volleying Ability

3.2.2 INDEPENDENT VARIABLE

1. Experimental group I - Specific Skill Training
2. Experimental group II -Neuromuscular Training
3. Control group IV - No training

3.3 EXPERIMENTAL DESIGN

To achieve the purpose of the study, random group design was selected. The subjects were randomly assigned into three equal groups of 10 each. The group was assigned as Experimental group I, Experimental group II and control group. The experimental groups were undergone in their training for a period of 12 weeks. The pre and post test was conducted on the above said variables before and after the 12 weeks for all the three groups. The training program was scheduled at 5.00 pm to 7.00 pm on alternate days.

3.4 PILOT STUDY

A pilot study was conducted before analyzing of training programme to ensure the suitability and duration of exercise. Five subjects each from Experimental groups were utilized for the pilot study. Further it helps to training the exercises and knows the difficulty of conducting training programme and the duration which is requires for conducting the test.

3.5 CRITERION MEASUREMENTS

The following criterion measures were chosen for the testing the hypotheses.

TABLE – I
SELECTION TESTS

S. No	Variables	Test	Unite of Measurement
Physical FitnessVariables			
1	Speed	50 meter sprint	Seconds
2	Agility	‘T’ test	Seconds
3	Flexibility	Sit and Reach	Centimeters
4	Arm strength	1RM test	Kg
5	Leg explosive power	Vertical jump	Centimeters
PhysiologicalVariables			
1.	Anaerobic Power	Margaria-Kalamen Test	Kilogram/meter/seconds
2.	Maximal oxygen uptake	1.5 mile run/walk	ml/kg/min
Skill Related Variables			
1.	Short Service	French Short Service Test	Points
2.	Long Service	Scott and French Long Service Test	Points
3.	Forehand Clear	Poole Forehand Clear Test	Points
4.	Backhand Clear	Poole Forehand Clear Test	Points
5.	Volleying Ability	Miller Wall Volley Test	Numbers

3.6 RELIABILITY OF DATA

The reliability of data was ensured by establishing the instrument reliability, tester reliability, test competency and subject's reliability.

3.7 RELIABILITY OF INSTRUMENTS

The research scholar used the following for measuring instruments of various tests. The Measuring tape, stop watch were standardized ones. As such the reliability is well established.

3.8 SUBJECT RELIABILITY

To determine the reliability of the subjects of badminton players selected as subjects were divided into three groups as control group, experimental group I and experimental group II. Then the initial test and final test were conducted. The test conducted for tester's reliability ensured the subject reliability.

Before the commencements of experiment, the reliability of the data were established through test and retest method. Results presented in the coefficient correlation table.

TABLE – II
INTRA CLASS CO-EFFICIENT OF CORRELATION ON SELECTED
VARIABLES

S. No	Variables	'r' Value
Physical Fitness Variables		
1	Speed	98*
2	Agility	96*
3	Flexibility	97*
4	Arm strength	95*
5	Leg explosive power	94*
Physiological Variables		
1	Anaerobic Power	93*
2	Maximal oxygen uptake	92*
Skill Related Variables		
1	Short Service	93*
2	Long Service	92*
3	Forehand Clear	91*
4	Backhand Clear	90*
5	Volleying Ability	91*

*Significant, Critical r value 0.71 with df 8

3.9 ORIENTATION OF THE SUBJECTS

Prior to the test the investigator explained to the subject about the purpose of the specific skill training and neuromuscular training. Investigator explained brief introduction regarding the purpose, effects, and benefits of the training to the subjects participating on the study. The study with a view to get full, cooperation from the subject and also to motivate them to exhibit their level of performance in the training to obtain maximum subjects reliability.

3.10 TRAINING SCHEDULE

3.10.1 SPECIFIC SKILL TRAINING PROGRAMS

SHADOW AND SHUTTLE DRILLS

A badminton drill will normally involve two people. One will of course perform the drills whilst another person will feed the shuttle. In these trainings, shadow strokes are combined with actual strokes to increase skills and shot accuracy.

SHUTTLE CONTROL DRILLS

Shuttle control is mainly about 1 player (The trainer) standing at corner guiding the trainee. The trainees in this training should return all the shots to the player who is guiding him. This training method has a lot of benefit such as:

1. Increase endurance level
2. Strengthen leg's strength

3. Increase shot's accuracy and consistency
4. Improving concentration level
5. Increasing speed and the ability to maintain the speed
6. To condition yourself for long rallies
7. To sharpen the quality of shots

Shuttle control Drills involves mostly full court movements. The physical ability and skills required are more complex and complicated. Shuttle control drills concentrates more on fluid movements and shots quality. It will also sharpen players' reflex towards any shots.

MULTIPLE SHUTTLES DRILLS

Multiple-shuttle drills are mainly done with 1 person delivering a lot of shuttles to every corner of the court to train the players. For the trainee to get the most benefit out of this training, the shuttles delivered to him must be accurate and consistent. The person who is delivering it must have some skills in doing so. From this training method, players can:

1. Improve shot accuracy and consistency
2. Increase endurance level
3. Strengthen leg's strength
4. Improve concentration level
5. Increase speed and the ability to maintain the speed

SPECIFIC SKILL TRAINING PROGRAMS

Ist– IVthWEEK 60 % to 70%

S. No	Name of Specific Skill Drills	Repetition	Sets	Rest
Shadow and Shuttle Drills				
1	Smash, Lift & Whip	6 Rep	2sets	30 sec
2	Defensive Drills	10 shuttles	2sets each side.	30 sec
3	Half court smash & Follow up	10 shuttles	2sets	30 sec
4	Baseline smash	10 shuttles	2sets	30 sec
5	Backhand drop shot drill	10 shuttles	2sets	30 sec
6	Backhand lob drill	10 shuttles	2sets	30 sec
Shuttle Control Drills				
7	Full court (front) shuttle control	20 shots	2sets	30 sec
8	Full court (baseline) shuttle control	20 shots	2sets	30 sec
9	Full court (front and baseline) shuttle control	20 shots	2sets each side.	30 sec
10	Full court + (baseline & baseline) shuttle control	20 shots	2sets each side.	30 sec
11	Full court (front and back) shuttle control	20 shots	2sets each side.	30 sec
12	Full court (Flat Drive) shuttle control	20 shots	2sets	30 sec
Multiple Shuttles Drills				
13	Smash and net multi-shuttle drills	15 shuttles	2sets	30 sec
14	Defensive style multi-shuttle drill	15 shuttles	2sets	30 sec
15	Attacking Style multi-shuttle drill	15 shuttles	2sets	30 sec

SPECIFIC SKILL TRAINING PROGRAMS

Vth– VIIIthWEEK 70 % to 80%

S. No	Name of Specific Skill Drills	Repetition	Sets
	Shadow and Shuttle Drills		
1	Smash, Lift & Whip	6 Rep	3sets
2	Defensive Drills	15 shuttles	3sets each side.
3	Half court smash & Follow up	15 shuttles	3sets
4	Baseline smash	15 shuttles	3sets
5	Backhand drop shot drill	15 shuttles	3sets
6	Backhand lob drill	15 shuttles	3sets
	Shuttle Control Drills		
7	Full court (front) shuttle control	25shots	3sets
8	Full court (baseline) shuttle control	25 shots	3sets
9	Full court (front and baseline) shuttle control	25 shots	3sets each side.
10	Full court + (baseline & baseline) shuttle control	25 shots	3sets each side.
11	Full court (front and back) shuttle control	25 shots	3sets each side.
12	Full court (Flat Drive) shuttle control	25 shots	3sets
	Multiple Shuttles Drills		
13	Smash and net multi-shuttle drills	20 shuttles	3sets
14	Defensive style multi-shuttle drill	20 shuttles	3sets
15	Attacking Style multi-shuttle drill	20 shuttles	3sets

SPECIFIC SKILL TRAINING PROGRAMS

IXth– XIIthWEEK 80 % to 90%

S. No	Name of Specific Skill Drills	Repetition	Sets
	Shadow and Shuttle Drills		
1	Smash, Lift & Whip	6 Rep	4sets
2	Defensive Drills	20 shuttles	4sets each side.
3	Half court smash & Follow up	20 shuttles	6sets
4	Baseline smash	20 shuttles	4sets
5	Backhand drop shot drill	20 shuttles	4sets
6	Backhand lob drill	20 shuttles	4sets
	Shuttle Control Drills		
7	Full court (front) shuttle control	30 shots	4sets
8	Full court (baseline) shuttle control	30 shots	4sets
9	Full court (front and baseline) shuttle control	30 shots	4sets each side.
10	Full court + (baseline & baseline) shuttle control	30 shots	4sets each side.
11	Full court (front and back) shuttle control	30 shots	4sets each side.
12	Full court (Flat Drive) shuttle control	30 shots	4sets
	Multiple Shuttles Drills		
13	Smash and net multi-shuttle drills	25 shuttles	4sets
14	Defensive style multi-shuttle drill	25 shuttles	4sets
15	Attacking Style multi-shuttle drill	25 shuttles	4sets

3.10.2 NEUROMUSCULAR TRAINING PROGRAM

The Neuromuscular Training(NMTP) group participated in 12weeks of Neuromuscular Training Programthrice a week. TheNeuromuscular Training program is going to fix at an Intensity of 60–90%. Each session consisted of 10-minutes warm-up include Running hip out, Running hip in, running circling, Jog line to line, Shuttle run, Backward running,static and dynamic flexibility exercise. Neuromuscular Training Programconsists of45-minute increments of combine balance, strength, plyometric, agility, and sport-specific exercises, and a 5-minute cool-down that included static and dynamic stretches for Calf, Quadriceps, Hamstring, Inner thigh and Hip flexors.

According to Myer and colleagues (Myer, et al., 2011), neuromuscular training (NT) is a conceptual training model that is defined as a training program to incorporate general (e.g., fundamental movements) and specific (e.g., sport-specific movements) strength and conditioning activities, such as resistance, dynamic stability, core-focused strength, plyometric, and agility, that are designed to enhance health and skill-related components of physical fitness.

THE NEROMUSCULAR TRAINING PROTOCOL

Ist– IVthWEEK 60 % to 70%

S. No	Name of Exercise	Repetition	Sets	Rest
1	Barbell squat	8 - 10 Rep	2Sets	2-3 Mint Rest
2	Barbell bench press	8 - 10 Rep	2Sets	2-3 Mint Rest
3	Bicep Curl	8 - 10 Rep	2Sets	2-3 Mint Rest
4	Assisted Russian hamstring curl	8 - 10 Rep	2Sets	2-3 Mint Rest
5	Latissimus pull-down	8 - 10 Rep	2Sets	2-3 Mint Rest
6	Lateral Hops over Cone	30sec	2Sets	90 sec
7	Forward/Backward Hops over cone	30sec	2Sets	90 sec
8	Single Leg hops Over cone	30sec	2Sets	90 sec
9.	Vertical Jumps With headers	30sec	2Sets	90 sec
10	Scissors Jump	30sec	2Sets	90 sec
11	Forward run with 3 step deceleration	-	2Sets	90 sec
12	Bounding run (44 yds)	-	2Sets	90 sec

HRR method: Target heart rate (HR) = [(HRmax – resting HR) × % intensity desired] + resting HR

1-RM method: One-repetition maximum

THE NEROMUSCULAR TRAINING PROTOCOL

Vth– VIIIth WEEK 70 % to 80%

S. No	Name of Exercise	Repetition	Sets	Rest
1	Barbell squat	6-8 Rep	3Sets	2-3 Mint Rest
2	Barbell bench press	6-8 Rep	3Sets	2-3 Mint Rest
3	Bicep Curl	6-8 Rep	3Sets	2-3 Mint Rest
4	Assisted Russian hamstring curl	6-8 Rep	3Sets	2-3 Mint Rest
5	Latissimus pull-down	6-8 Rep	3Sets	2-3 Mint Rest
6	Lateral Hops over Cone	30sec	3Sets	90 sec
7	Forward/Backward Hops over cone	30sec	3Sets	90 sec
8	Single Leg hops Over cone	30sec	3Sets	90 sec
9.	Vertical Jumps With headers	30sec	3Sets	90 sec
10	Scissors Jump	30sec	3Sets	90 sec
11	Forward run with 3 step deceleration	-	3Sets	90 sec
12	Bounding run (44 yds)	-	3Sets	90 sec

HRR method: Target heart rate (HR) = [(HRmax – resting HR) × % intensity desired] + resting HR

1-RM method: One-repetition maximum

THE NEROMUSCULAR TRAINING PROTOCOL IXth– XIIth WEEK

80 % to 90%

S. No	Name of Exercise	Repetition	Sets	Rest
1	Barbell squat	4-6 Rep	4Sets	2-3 Mint Rest
2	Barbell bench press	4-6 Rep	4Sets	2-3 Mint Rest
3	Bicep Curl	4-6 Rep	4Sets	2-3 Mint Rest
4	Assisted Russian hamstring curl	64-6 Rep	4Sets	2-3 Mint Rest
5	Latissimus pull-down	4-6 Rep	4Sets	2-3 Mint Rest
6	Lateral Hops over Cone	30sec	4Sets	90 sec
7	Forward/Backward Hops over cone	30sec	4Sets	90 sec
8	Single Leg hops Over cone	30sec	4Sets	90 sec
9.	Vertical Jumps With headers	30sec	4Sets	90 sec
10	Scissors Jump	30sec	4Sets	90 sec
11	Forward run with 3 step deceleration	-	4Sets	90 sec
12	Bounding run (44 yds)	-	4Sets	90 sec

HRR method: Target heart rate (HR) = [(HRmax – resting HR) × %

intensity desired] + resting HR

1-RM method: One-repetition maximum

3.11 TEST ADMINISTRATION

3.11.1 FLEXIBILITY (SIT AND REACH TEST)

Purpose

To measure the muscular flexibility.

Equipments Used

Measuring stick and mat.

Procedure

The subject sit on the mat, both legs were extended forward, the measuring stick was placed on the floor in-between both legs. The zero end of the measuring stick was placed as proximal end. The subject bent forward and extends both arms forward. The zero point of the measuring stick was placed to the tip of the middle finger. The subject slowly stretch forwards the hip, back and the arm. The maximum distance reached was recorded with the help of measuring stick in cm. Three trials were given with adequate rest in between (**Johnson and Nelson, 1988**).

Scoring

The best of three trials was treated as final score in centimeters.

3.11.2 ARM STRENGTH (1RM BENCH PRESS)

PURPOSE

To evaluate arm strength of the subject.

EQUIPMENTS AND FACILITIES REQUIRED

Bar bell, weight plates set and collar

PROCEDURES

One repetition maximum tests (1-RM) is a popular method of measuring isotonic muscle strength. It is a measure of the maximal weight a subject can lift with one repetition. It is so important to reach the maximum weight without prior fatiguing the muscles. After a warm up, choose a weight that is achievable. Then after a rest of at least several minutes, increase the weight and try again. The subjects chooses subsequent weights until they can only repeat one full and correct lift of that weight.

SCORING:

The maximum weight lifted in kilograms is recorded (Mackenzic, 2005).

3.11.3 LEG EXPLOSIVE POWER (SARGENT VERTICAL JUMP)

Purpose

To measure leg explosive power of the subjects.

Equipment's and facilities required

A plywood board as suggested by sargent was used to obtain the data.

Procedure

To obtain data for vertical jump, sargent jump was administered to the subjects. Before the execution of the test, all the subjects were directed by the tester regarding the test performance. The subjects were taught how to perform the test perfectly by the investigator. Before the execution of the vertical jump test, subjects were directed to practice for a few minutes. A plywood board (blackened 1 cm, Thick 1.50 mts long and 50 cm wide) with lines marked horizontally 1 cm. apart was used. This board was placed vertically, the zero point of the scale being at the reaching height of the shortest subject tested. The subject stood with his side toward the wall and reached as high as possible with heels on the floor and made a mark on the wall with chalked fingers. The subject then swung his arms downward and backward assuming a crouched position with the knees bent at about right angle. The subject then jumped as high as possible, swinging the arms upward, as the highest point of the jump

was reached, another mark was made above the initial one. Three trials were allowed one-minute rest in between.

Scoring

The score was recorded to the nearest centimetres, between the reach and jump mark. The best of the three trials was recorded as the test score. (Johnson, 1998).

3.11.4 FRENCH SHORT

Service Test Purpose

To measure the ability to serve accurately with a low and short placement of the subject.

Equipment and facilities required

Badminton court with all marking, ropes, poles, racket, cock and score sheet were used.

Administration and Direction

A cloths-line rope is stretched 20 inches directly above the net and parallel to the net. A series of 2-inch lines in the form of arcs are placed at distances of 22, 30, 38, and 26 inches from the midpoint of the intersection of the centre line and the short-service line of the right service court. Each measurement includes the width of the 2-inch lines. The test performer may stand anywhere in the right service area, diagonally opposite the target. Twenty legal serves (may be two groups of ten) are attempted at the (b) the target (see figure –

3.1). To earn points, the serve must pass between the rope and net and lands somewhere in the proper service court area for doubles play.

Scoring

A score is awarded to any legal serve that passes between the rope and net and lands in the proper service court for doubles play. A score of '0' is recorded for any shuttle that does not pass in between the rope and the net. The awarded points (5, 4, 3, 2 and 1) are based on t hits the rope, the trial is not counted. The score of the entire test is the total of 20 trials and illegal serves are repeated.

(Miller, 2002)

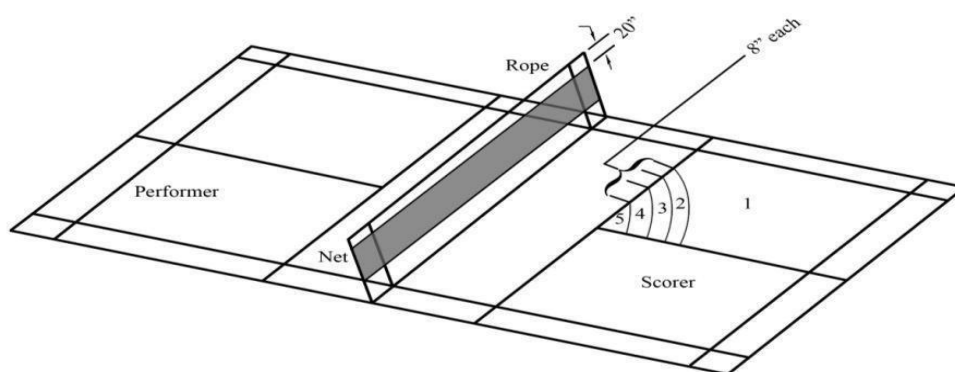


Figure-1. Diagram of French Short Service Test

3.11.5 SCOTT AND FRENCH LONG

Service Test Purpose

To measure the accuracy of the long serves of the subjects.

Equipments and facilities required

Badminton court with all marking, ropes, poles, racket, cock and score sheet were used.

Administration and Direction

With the use of additional standards, a rope is stretched across the court 14 feet from and parallel to the net at a height of 8 feet. Floor markings are identical to those described for the French short service test except for their location. The intersection of the long service line and left side boundary line for singles is used for placement of the target (see figure – 3.2). Standing any way where in the service court diagonally across from the target, the performer attempts twenty legal serves over the net and rope to the target area.

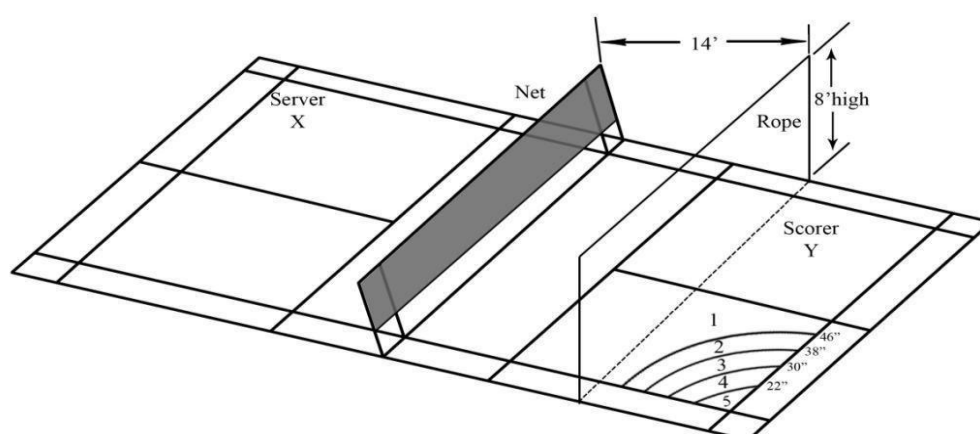


Figure-2. Diagram of Scott - French Long Service Test

Scoring

A score (5, 4, 3, 2 or 1) is awarded to any legal serve that passes over the net and rope and lands in the target area. Services that hit the rope are taken over, and shuttles that land on a target line are awarded the point value of the higher target. The test score is the sum of the twenty serves. and any serve that lands beyond the back line receives 0 points. Because most opponents play serves that would land close to develop a point system that includes an area 2 to 3 inches beyond the back line. **(Miller 2002).**

3.11.6 FOREHAND / BACKHAND CLEAR TEST

Purpose

The purpose of the test was to measure the ability to hit the forehand / backhand clear from the backcourt, high and deep into the opponent's court.

Equipments and facilities required

Badminton court with all markings, rackets, cocks, and score sheet were used.

Administration and Direction

The scoring zones are marked as shown in figure – 3. A 15” X 15” square is drawn 11 feet from the net astride the center line (O in Figure – 3.3). Another square of equal size is drawn on the other side of the court at the intersection of the doubles long-service line and the centreline(X in figure – 3.3). If right-handed, the test performer stands with the right foot on the X square (left-handed, left foot) and

a player stands at point 'O' with a racket extended overhead. The performer places a shuttle, with the feather end down, on the forehand side of the racket, tosses the shuttle into the air, and hits it with an overhead forehand clear over the player's extended racket.

Scoring

The point value of the zone in which the shuttle lands were recorded, and the best ten of twelve shots are totalled for the test score. Shuttle landing on a target line are given the higher point value, and one point is deducted for any shuttle that fails to clear the extended racket of the player. The maximum score is 40.

The test performer should practise the tossing of the shuttle. The test also can be used to measure the backhand clear: the right-hand performer stands with the left foot in the X square, place the shuttle on the forehand side of the racket, tosses it into the air, and executes a backhand clear deep into the opponent's court.

(Miller2002).

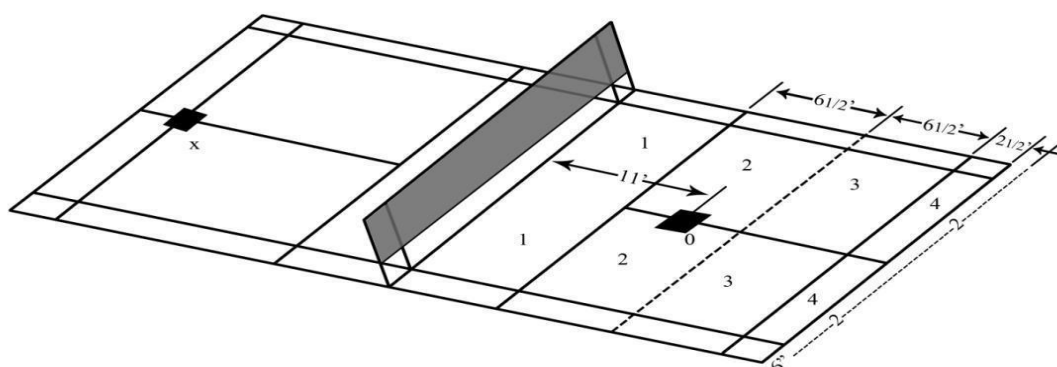


Figure-3. Diagram of Poole Forehand / Backhand Clear Test

3.12 COLLECTION OF DATA

Specific Skill training and Neuromuscular training were given as per the training schedule of 12 weeks. The pre and post test data on the selected criterion variables were collected by administering the test as per the standardized procedures before and after the 12 weeks of the training programme.

3.13 STATISTICAL TECHNIQUES

The following statistical technique was adopted to treat the collected data in connection with established hypotheses and objectives of this study.

To find out the difference between pre and post test of each groups, paired't' test was used. Analysis of covariance (ANCOVA) was compute because the subjects are selected random, but the groups are not equated in relation to the factors to be examined. Hence the difference between means of the three groups in the pre-test have to be taken into account during the analysis of the post-test differences between the means. This was achieved by the application of the analysis of covariance, where the final means were adjusted for differences in the initial means, and the adjusted means are tested for significance.

Whenever the adjusted post-test means were found significant, the Scheffe's post-hoc test was administer to find out the paired means difference. To test the obtained results on variables, level of significance 0.05 is chosen and considered as sufficient for the study.

CHAPTER - IV

RESULTS AND DISCUSSIONS

4.1 OVERVIEW

This chapter deals with the analysis of data obtained from the samples under study. The purpose of the study was to determine the impact of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

To achieve the purpose of the study, thirty (N=30) state level junior male badminton players were selected randomly in the age group of 16 and 18 years Chennai. They were assigned into three group's namely experimental group I (specific skill training), experimental group II (neuromuscular training) and group III acted as Control Group. Experimental groups underwent training for a period of 12 weeks. The data collected from experimental group and control groups on selected physical physiological and skill related variables in relation to and adjusted post test scores were subjected to statistical analysis using paired 't' test to analyse the significant difference if any between pre-test, post-test. Further, Analysis of Covariance (ANCOVA) to find out the significance among the mean differences, whenever the 'F' ratio for

adjusted test was found to be significant, Scheffe's post hoc test was used. In all cases 0.05 level of significance was fixed to test hypotheses.

4.2 TEST OF SIGNIFICANCE

This is the vital portion of the thesis, that of achieving at the conclusion by examining the hypothesis. The tests were usually called as the test of significance, since there would be any difference between the pre-test and post-test scores of the samples are significant or not. In the present study, if they obtained F-ratio value was equal to or greater than the table value, the research hypothesis was accepted. The hypothesis was rejected if the obtained F-ratio was lesser than the table value.

4.3 LEVEL OF SIGNIFICANCE

To test the obtained results on all the variables, level of significance 0.05 was chosen and considered as sufficient for the study.

4.4 COMPUTATION OF 't' TEST

The statistical analysis on significance of the mean gains or losses made in the scores in the variables related to selected physical physiological and skill related variables among badminton players of specific skill training (ST) and neuromuscular training (NT) groups are presented in tables III to IV.

TABLE – III
MEAN GAINS AND LOSSES BETWEEN PRE AND POST TEST SCORES
OF SPECIFIC SKILL TRAINING GROUP

S.No	Variables	Pre Test Mean	Post Test Mean	MD	Std. Dev.(±)	‘t’ Ratio
1.	Speed	9.11	8.83	0.28	0.12	7.56*
2.	Agility	11.96	11.64	0.32	0.56	1.79
3.	Flexibility	23.15	25.30	-2.15	1.54	4.40*
4.	Arm Strength	43.30	45.50	-2.20	1.55	4.49*
5.	Leg Explosive Power	24.30	26.50	-2.20	0.63	11.00*
6.	Anaerobic Power	1271.60	1390.00	-118.40	46.08	8.12*
7.	Maximal Oxygen Uptake	36.24	45.21	-8.97	2.17	13.06*
8.	Short Service	59.50	64.40	-4.90	3.48	4.45*
9.	Long Service	59.60	65.40	-5.80	5.67	3.23*
10	Forehand Clear	45.00	55.80	-10.80	3.49	9.79*
11	Backhand Clear	45.80	56.20	-10.40	3.57	9.22*
12	Volleying Ability	12.00	15.60	-3.60	2.37	4.81*

*Significant at 0.05 level (df, 9 = 2.26)

An examination of Table-III indicates that the obtained 't'values for the specific skill training on selected variables: Speed (7.56), Flexibility (4.40), Arm strength (4.49), Leg explosive power (11.00), Anaerobic Power (8.12), Maximal oxygen uptake (13.06), Short Service (4.45), Long Service (3.23), Forehand Clear (9.79), Backhand Clear (9.22), Volleying Ability(4.81). The obtained 't'values to be significant at 0.05 level for degree of freedom 9 the required critical value was 2.26.Hence, the obtained t-values on the variables higher than the required table values. It was concluded that the specific skill training group produced significant improvement in above said variables.

An examination of Table-III indicates that the obtained 't'values for the specific skill training on Agility (1.79). The obtained 't'values to be significant at 0.05 level for degree of freedom 9 the required critical value was 2.26.Hence, the obtained t-values on the variable lesser than the required table value. It was concluded that the specific skill training group did not produced significant improvement in above said variable.

TABLE – IV

**MEAN GAINS AND LOSSES BETWEEN PRE AND POST TEST
NEUROMUSCULAR TRAINING GROUP**

S.No	Variables	Pre Test Mean	Post Test Mean	MD	Std. Dev (±)	‘t’ Ratio
1.	Speed	8.78	8.46	0.32	0.29	3.49*
2.	Agility	11.93	11.65	0.28	0.91	0.99
3.	Flexibility	24.09	26.14	-2.05	1.41	4.59*
4.	Arm Strength	43.90	46.00	-2.10	2.23	2.97*
5.	Leg Explosive Power	23.10	26.40	-3.30	1.49	6.98*
6.	Anaerobic Power	1301.20	1433.60	-132.40	47.29	8.85*
7.	Maximal Oxygen Uptake	36.04	45.88	-9.83	1.13	27.62*
8.	Short Service	60.00	66.50	-6.50	4.09	5.03*
9.	Long Service	60.10	65.60	-5.50	5.62	3.09*
10.	Forehand Clear	46.60	55.60	-9.00	2.00	14.23*
11.	Backhand Clear	47.30	57.00	-9.70	4.64	6.61*
12.	Volleying Ability	12.20	16.10	-3.90	1.91	6.45*

*Significant at 0.05 level (df, 9 = 2.26)

An examination of Table-IV indicates that the obtained 't'values for the neuromuscular training on selected variables: Speed (3.49), Flexibility (4.59), Arm strength (2.97), Leg explosive power (6.98), Anaerobic Power (8.85), Maximal oxygen uptake (27.62), Short Service (5.03), Long Service (3.09), Forehand Clear (14.23), Backhand Clear (6.61), Volleying Ability (6.45). The obtained 't'values to be significant at 0.05 level for degree of freedom 9 the required critical value was 2.26. Hence, the obtained t-values on the variables higher than the required table values. It is concluded that the neuromuscular training group produced significant improvement in above said variables.

An examination of Table-IV indicates that the obtained 't'values for the neuromuscular training on Agility (0.99). The obtained 't'values to be significant at 0.05 level for degree of freedom 9 the required critical value was 2.26. Hence, the obtained t-values on the variable lesser than the required table value. It is concluded that the neuromuscular training group did not produced significant improvement in above said variable.

4.5 COMPUTATION OF ANALYSIS OF COVARIANCE ON SELECTED VARIABLES

The following table illustrates the statistical result of the specific skill training (ST) and neuromuscular training (NT) and control group (CG) on selected physical fitness physiological and skill variables among state level male junior badminton players.

4.5.1 RESULTS ON SPEED

TABLE – V

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON SPEED
(Scores in Seconds)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	9.11	8.78	8.90	Between	0.56	2	0.28	1.44
				Within	5.27	27	0.20	
Post Test	8.83	8.46	8.96	Between	1.31	2	0.66	3.28
				Within	5.41	27	0.20	
Adjusted	8.67	8.60	8.98	Between	0.84	2	0.42	8.52*
				Within	1.28	26	0.05	
Mean Gain	0.28	0.32	-0.06					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table – V show that the pretest means of specific skill training, neuromuscular training and control groups were 9.11, 8.78 and 8.90 respectively. The obtained F-ratio 1.44 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 8.83, 8.46 and 8.96 respectively. The obtained F-ratio 3.28 for the post-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were no significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 8.67, 8.60 and 8.98 respectively. The obtained F-ratio for the adjusted post-test value of 8.52 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table VI.

TABLE – VI
SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON SPEED
(Scores in Seconds)

STG	NTG	CG	MD	CI
8.67	8.60	-	0.07	0.26
8.67	-	8.98	0.31*	0.26
-	8.60	8.98	0.39*	0.26

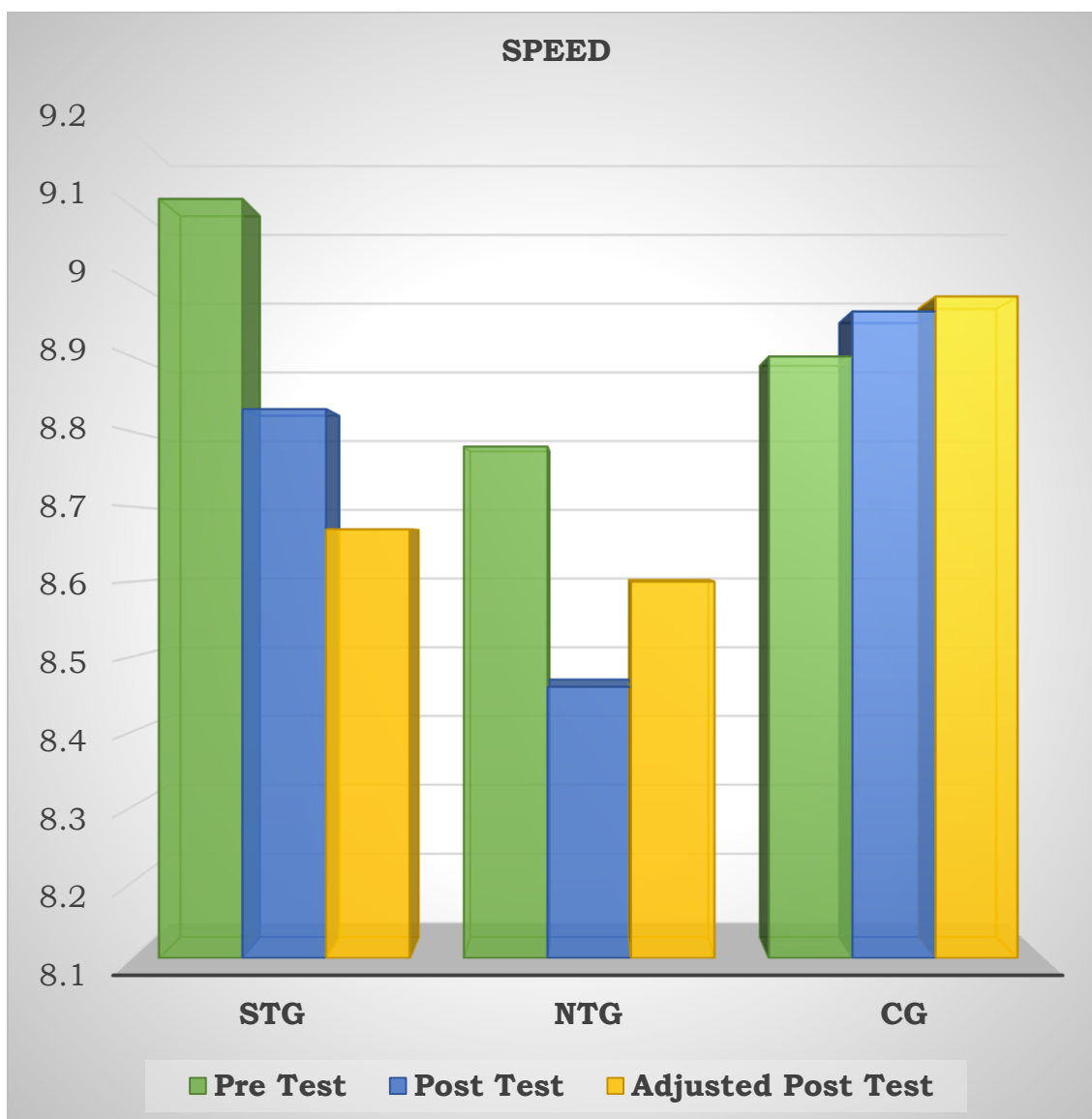
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table VI proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 0.26. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 0.26.

The pre, post and adjusted test mean values on speed were presented through bar diagram for better understanding of the results of this study in figure 4.

Figure – 4

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON SPEED OF EXPERIMENTAL AND
CONTROL GROUPS
(Scores in Seconds)**



4.5.2 RESULTS ON AGILITY

TABLE – VII

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON AGILITY
(Scores in Seconds)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	11.96	11.93	12.39	Between	1.30	2	0.65	1.07
				Within	16.42	27	0.61	
Post Test	11.64	11.65	12.46	Between	4.45	2	2.23	5.78*
				Within	10.39	27	0.38	
Adjusted	11.70	11.73	12.32	Between	2.24	2	1.12	4.49*
				Within	6.496	26	0.25	
Mean Gain	0.32	0.28	-0.08					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table –VII show that the pretest means of specific skill training, neuromuscular training and control groups were 11.96, 11.93 and 12.39 respectively. The obtained F-ratio 1.07 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 11.64, 11.65 and 12.46 respectively. The obtained F-ratio 5.78 for the post-test was higher than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 11.70, 11.73 and 12.32 respectively. The obtained F-ratio for the adjusted post-test value 4.49 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table VIII.

TABLE – VIII
SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON AGILITY
(Scores in Seconds)

STG	NTG	CG	MD	CI
11.70	11.73	-	-0.02	0.58
11.70	-	12.32	-0.61*	0.58
-	11.73	12.32	-0.59*	0.58

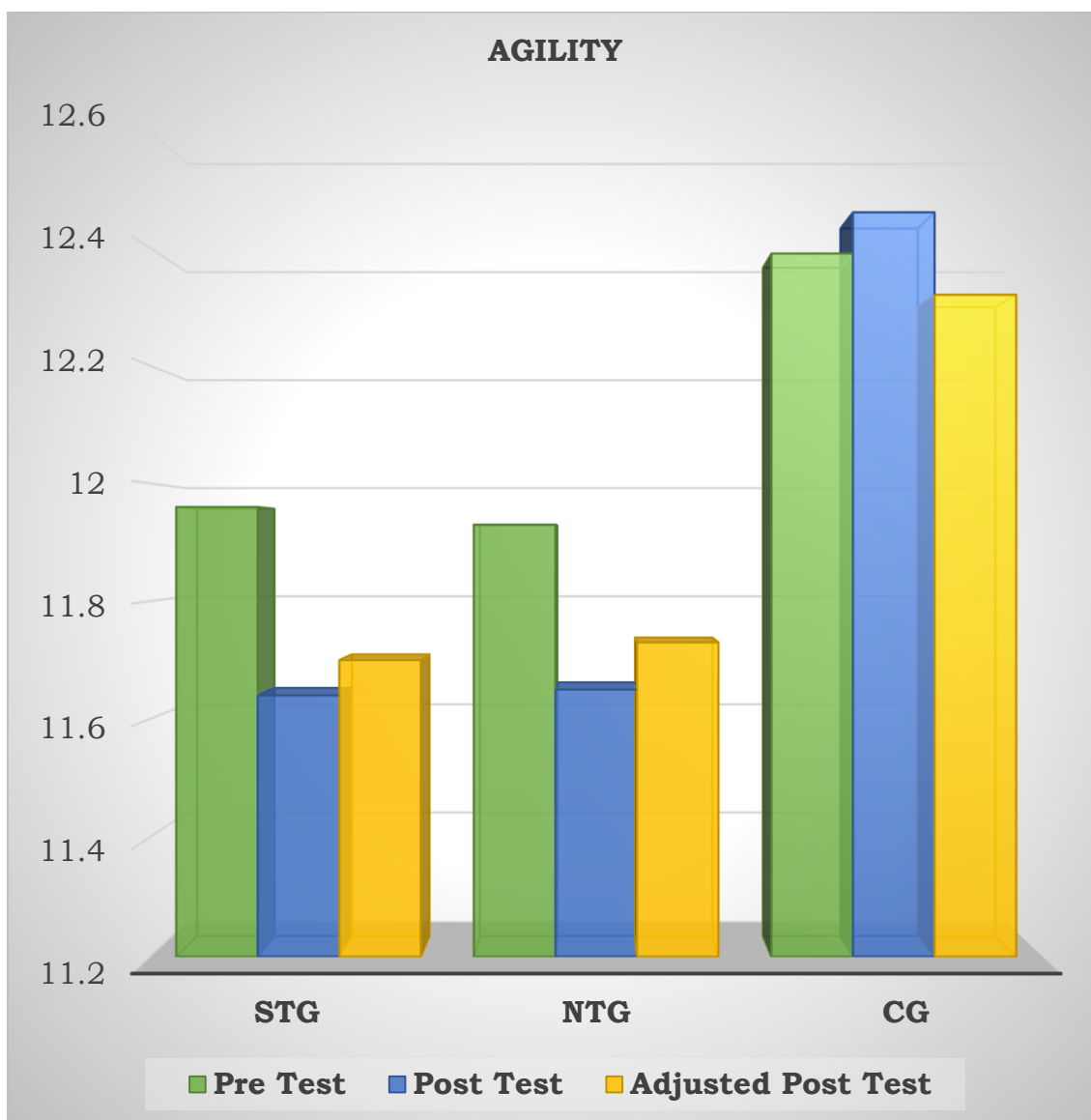
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table VIII proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 0.58. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 0.58.

The pre, post and adjusted test mean values on Agility were presented through bar diagram for better understanding of the results of this study in figure 5.

Figure – 5

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON AGILITY OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Seconds)**



4.5.3 RESULTS ON FLEXIBILITY

TABLE – IX

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON FLEXIBILITY
(Scores in cm)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	23.15	24.09	23.93	Between	5.06	2	2.53	1.19
				Within	57.62	27	2.13	
Post Test	25.30	26.14	24.01	Between	23.02	2	11.51	6.87*
				Within	45.23	27	1.68	
Adjusted	25.61	25.94	23.90	Between	23.97	2	11.98	10.97*
				Within	28.412	26	1.09	
Mean Gain	-2.15	-2.05	-0.08					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table –IX show that the pretest means of specific skill training, neuromuscular training and control groups were 23.15, 24.09 and 23.93 respectively. The obtained F-ratio 1.19 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 25.30, 26.14 and 24.01 respectively. The obtained F-ratio 6.87 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 25.61, 25.94 and 23.90 respectively. The obtained F-ratio for the adjusted post-test value 10.97 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table X.

TABLE – X
SCHEFFE’S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON FLEXIBILITY
(Scores in cm)

STG	NTG	CG	MD	CI
25.61	25.94	-	-0.33	1.21
25.61	-	23.90	1.71*	1.21
-	25.94	23.90	2.04*	1.21

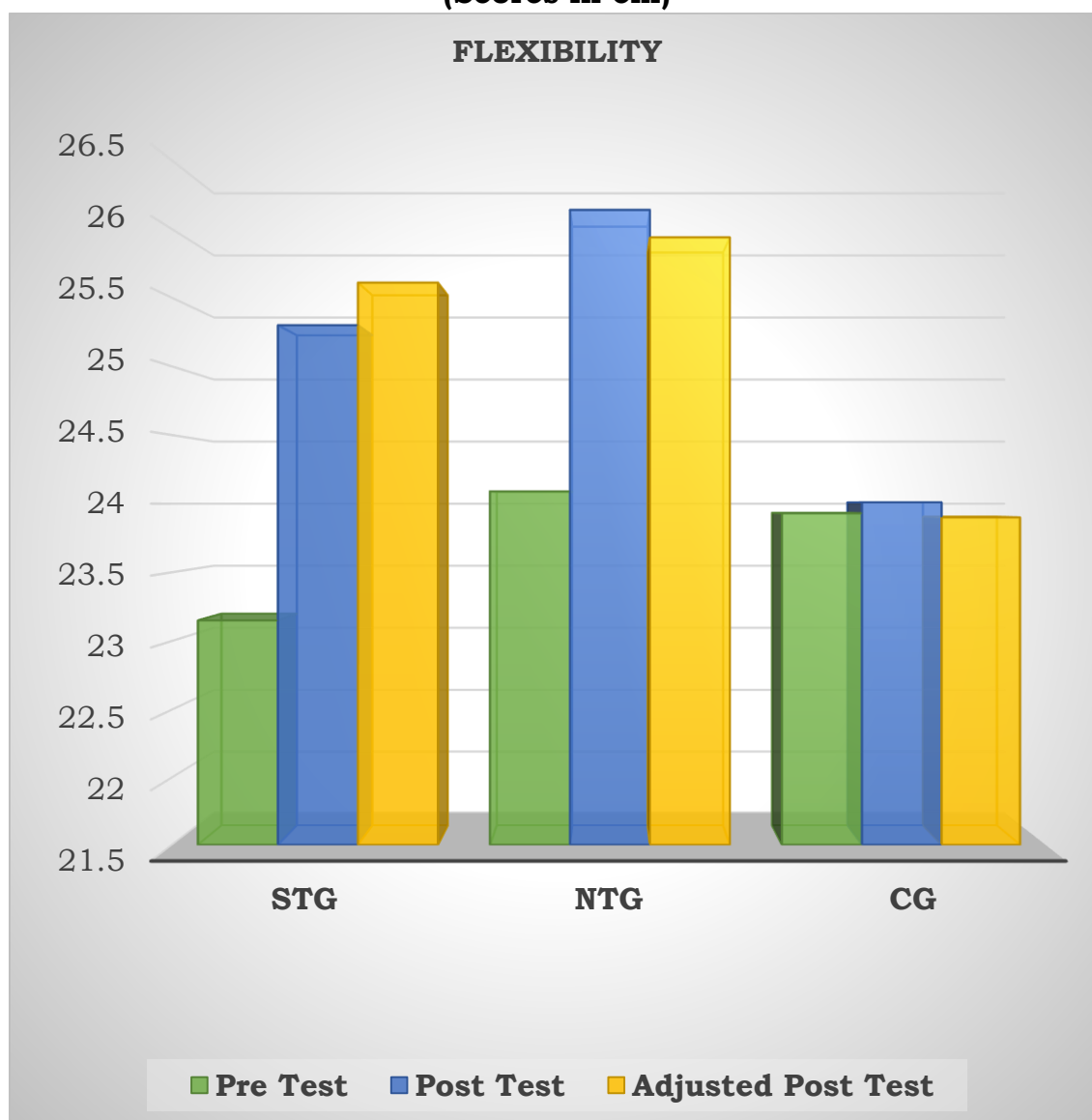
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table X proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 1.21. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 1.21.

The pre, post and adjusted test mean values on Flexibility were presented through bar diagram for better understanding of the results of this study in figure 6.

Figure – 6

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON FLEXIBILITY OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in cm)**



4.5.4 RESULTS ON ARM STRENGTH

TABLE – XI

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON ARM STRENGTH
(Scores in kg)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	43.30	43.90	45.20	Between	18.87	2	9.43	1.23
				Within	206.60	27	7.65	
Post Test	45.50	46.00	44.20	Between	17.27	2	8.63	1.31
				Within	178.10	27	6.60	
Adjusted	46.12	46.17	43.41	Between	46.17	2	23.09	9.29
				Within	64.646	26	2.49	
Mean Gain	-2.20	-2.10	1.00					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table –XI show that the pretest means of specific skill training, neuromuscular training and control groups were 43.30, 43.90 and 45.20 respectively. The obtained F-ratio 1.23 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 45.50, 46.00 and 44.20 respectively. The obtained F-ratio 1.31 for the post-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were no significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 46.12, 46.17 and 43.41 respectively. The obtained F-ratio for the adjusted post-test value 9.29 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XII.

TABLE – XII
SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON ARM STRENGTH
(Scores in kg)

STG	NTG	CG	MD	CI
46.12	46.17	-	-0.06	1.83
46.12	-	43.41	2.71*	1.83
-	46.17	43.41	2.76*	1.83

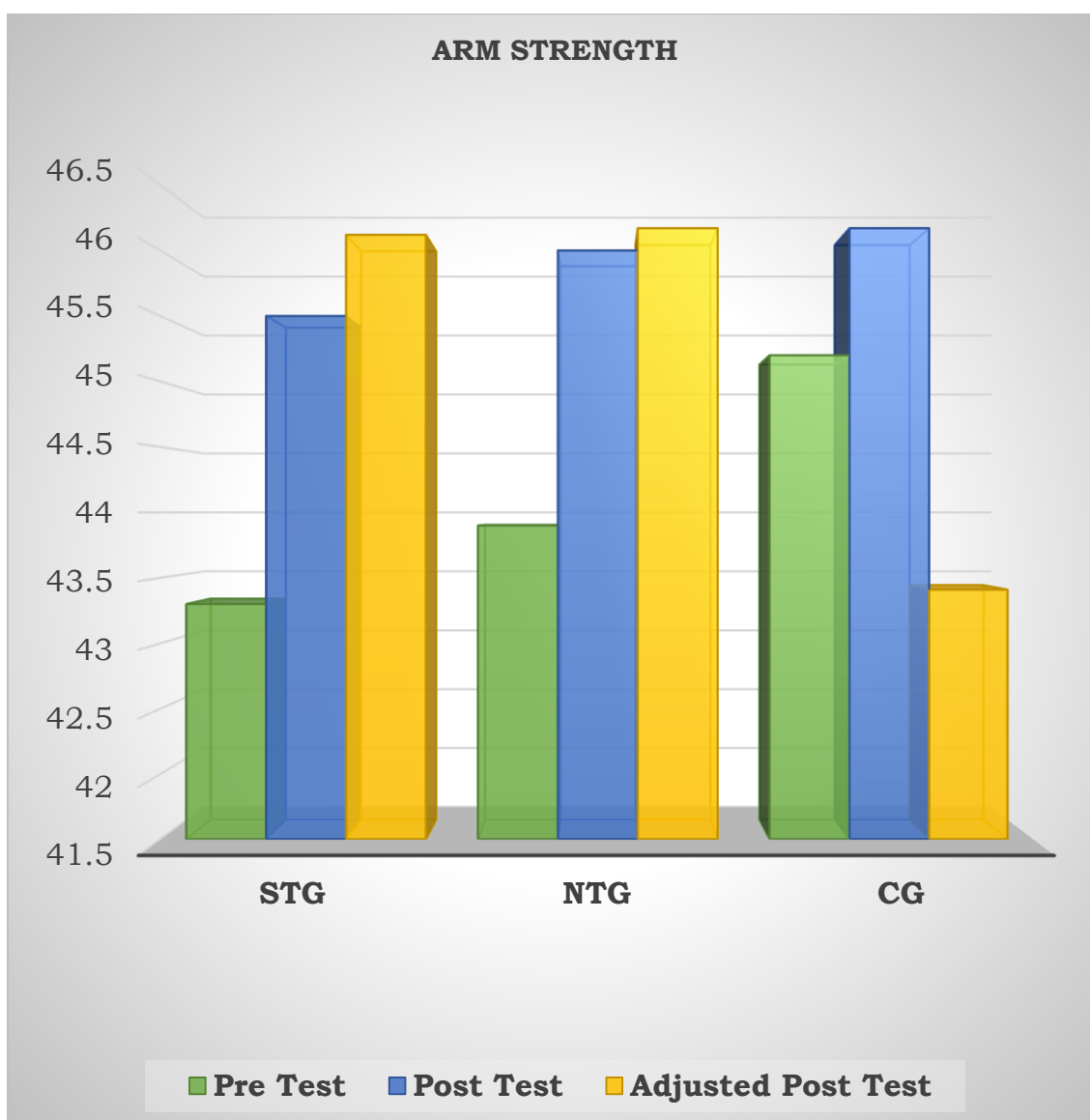
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XII proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 1.83. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 1.83.

The pre, post and adjusted test mean values on Arm Strength were presented through bar diagram for better understanding of the results of this study in figure 7.

Figure – 7

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON ARM STRENGTH OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in kg)**



4.5.5 RESULTS ON LEG EXPLOSIVE POWER

TABLE – XIII

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON LEG EXPLOSIVE POWER
(Scores in kg)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	24.30	23.10	23.20	Between	8.87	2	4.43	1.32
				Within	90.60	27	3.36	
Post Test	26.50	26.40	23.10	Between	74.87	2	37.43	14.08*
				Within	71.80	27	2.66	
Adjusted	26.04	26.66	23.30	Between	63.45	2	31.73	21.41*
				Within	38.53	26	1.48	
Mean Gain	-2.20	-3.30	0.10					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table - XIII show that the pretest means of specific skill training, neuromuscular training and control groups were 24.30, 23.10 and 23.20 respectively. The obtained F-ratio 1.32 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 26.50, 26.40 and 23.10 respectively. The obtained F-ratio 14.08 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were no significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 26.04, 26.66 and 23.30 respectively. The obtained F-ratio for the adjusted post-test value 21.41 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XIV.

TABLE – XIV
SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON LEG EXPLOSIVE POWER
(Scores in kg)

STG	NTG	CG	MD	CI
26.04	26.66	-	0.63	1.41
26.04	-	23.30	2.73*	1.41
-	26.66	23.30	3.36*	1.41

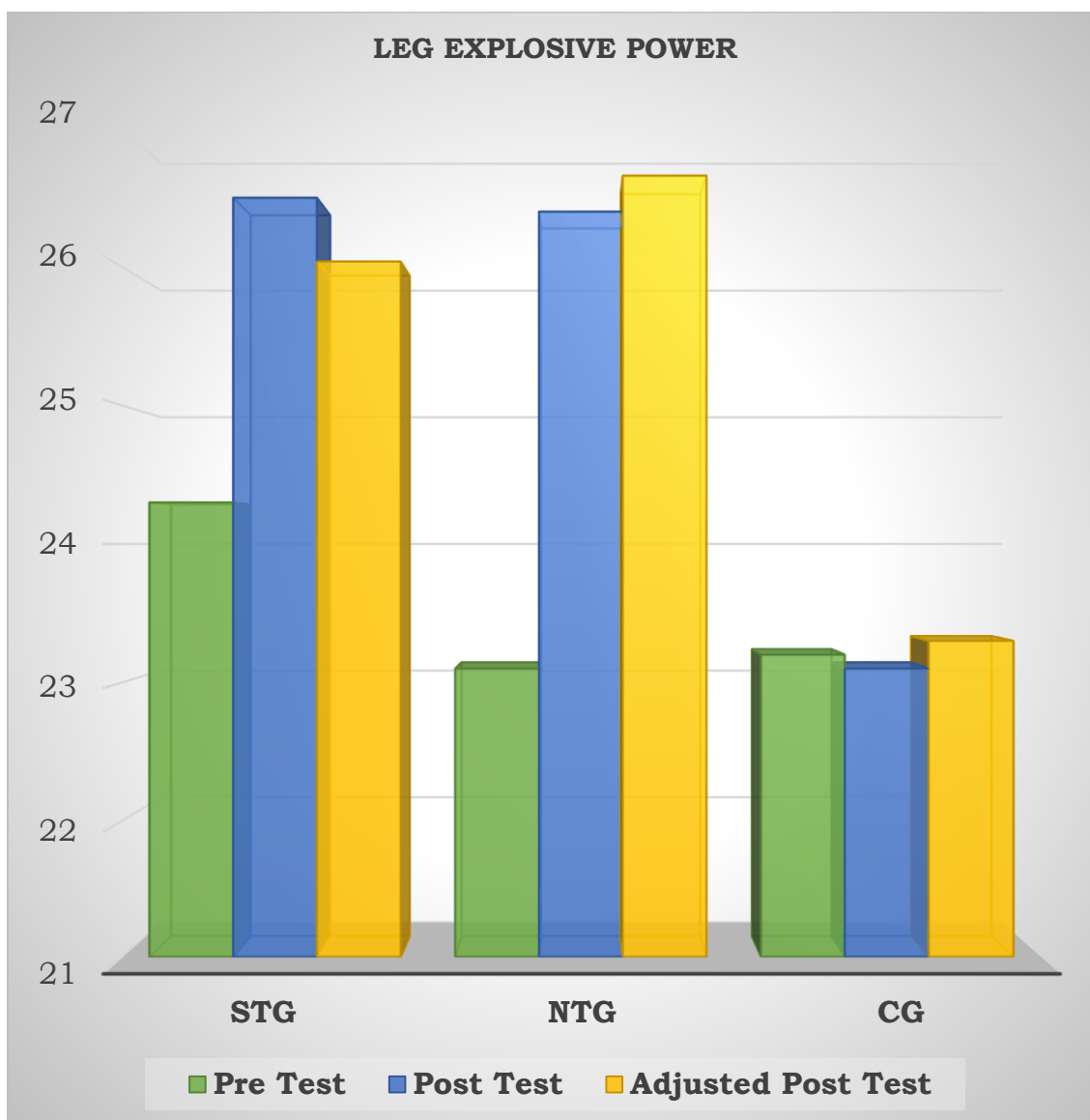
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XIV proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 1.41. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 1.41.

The pre, post and adjusted test mean values on leg explosive power were presented through bar diagram for better understanding of the results of this study in figure 8.

Figure – 8

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON LEG EXPLOSIVE POWER OF
EXPERIMENTAL AND CONTROL GROUPS
(Scores in cm)**



4.5.6 RESULTS ON ANAEROBIC POWER

TABLE – XV

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON ANAEROBIC POWER
(Scores in Kilogram/meter/seconds)**

Test	EX 1	EX 2	CG	SV	SS	df	MS	F
Pre Test	1271.60	1301.20	1266.90	B	6915.80	2	3457.90	1.64
				W	56870.90	27	2106.33	
Post Test	1390.00	1433.60	1275.40	B	133537.87	2	66768.93	44.89*
				W	40156.80	27	1487.29	
Adjusted	1393.66	1424.20	1281.14	B	106536.39	2	53268.19	47.63*
				W	29079.609	26	1118.45	
Mean Gain	-118.40	-132.40	-8.50					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table – XV show that the pretest means of specific skill training, neuromuscular training and control groups were 1271.60, 1301.20 and 1266.90 respectively. The obtained F-ratio 1.64 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 1390.00, 1433.60 and 1275.40 respectively. The obtained F-ratio 44.89 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 1393.66, 1424.20 and 1281.14 respectively. The obtained F-ratio for the adjusted post-test value 47.63 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XVI.

TABLE – XVI

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON ANAEROBIC POWER
 (Scores in Kilogram/meter/seconds)**

EX 1	EX 2	CG	MD	CI
1393.66	1424.20	-	-30.54	38.74
1393.66	-	1281.14	112.53	38.74
-	1424.20	1281.14	143.06	38.74

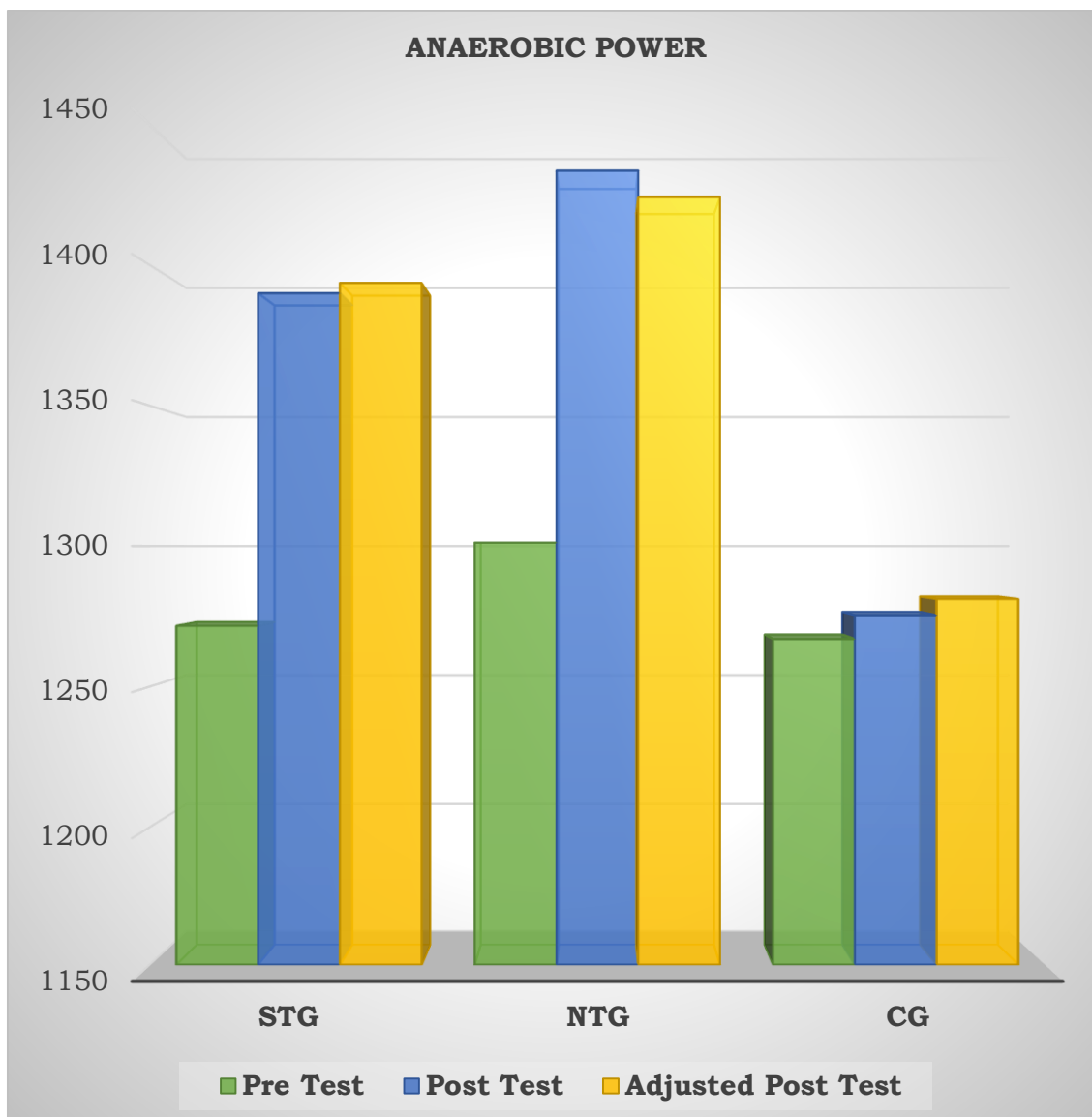
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XIV proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 38.74. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 38.74.

The pre, post and adjusted test mean values on anaerobic power were presented through bar diagram for better understanding of the results of this study in figure 9.

Figure – 9

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON ANAEROBIC POWER OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Kilogram/meter/seconds)**



4.5.7 RESULTS ON MAXIMAL OXYGEN UPTAKE

TABLE – XVII

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON MAXIMAL OXYGEN UPTAKE
(Scores in ml/kg/min)**

Test	EX 1	EX 2	CG	SV	SS	df	MS	F
Pre Test	36.24	36.04	35.73	B	1.34	2	0.67	1.92
				W	9.41	27	0.35	
Post Test	45.21	45.88	35.69	B	649.30	2	324.65	161.16*
				W	54.39	27	2.01	
Adjusted	45.09	45.86	35.83	B	559.80	2	279.90	140.18*
				W	51.914	26	2.00	
Mean Gain	-8.97	-9.83	0.03					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively.

The statistical analysis from the table –XVII show that the pretest means of specific skill training, neuromuscular training and control groups were 36.24, 36.04 and 35.73 respectively. The obtained F-ratio 1.92 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 45.21, 45.88 and 35.69 respectively. The obtained F-ratio 161.16 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 45.09, 45.86 and 35.83 respectively. The obtained F-ratio for the adjusted post-test value 140.18 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XVIII.

TABLE – XVIII

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON MAXIMAL OXYGEN UPTAKE
 (Scores in ml/kg/min)**

EX 1	EX 2	CG	MD	CI
45.09	45.86	-	-0.77	1.64
45.09	-	35.83	9.26	1.64
-	45.86	35.83	10.02	1.64

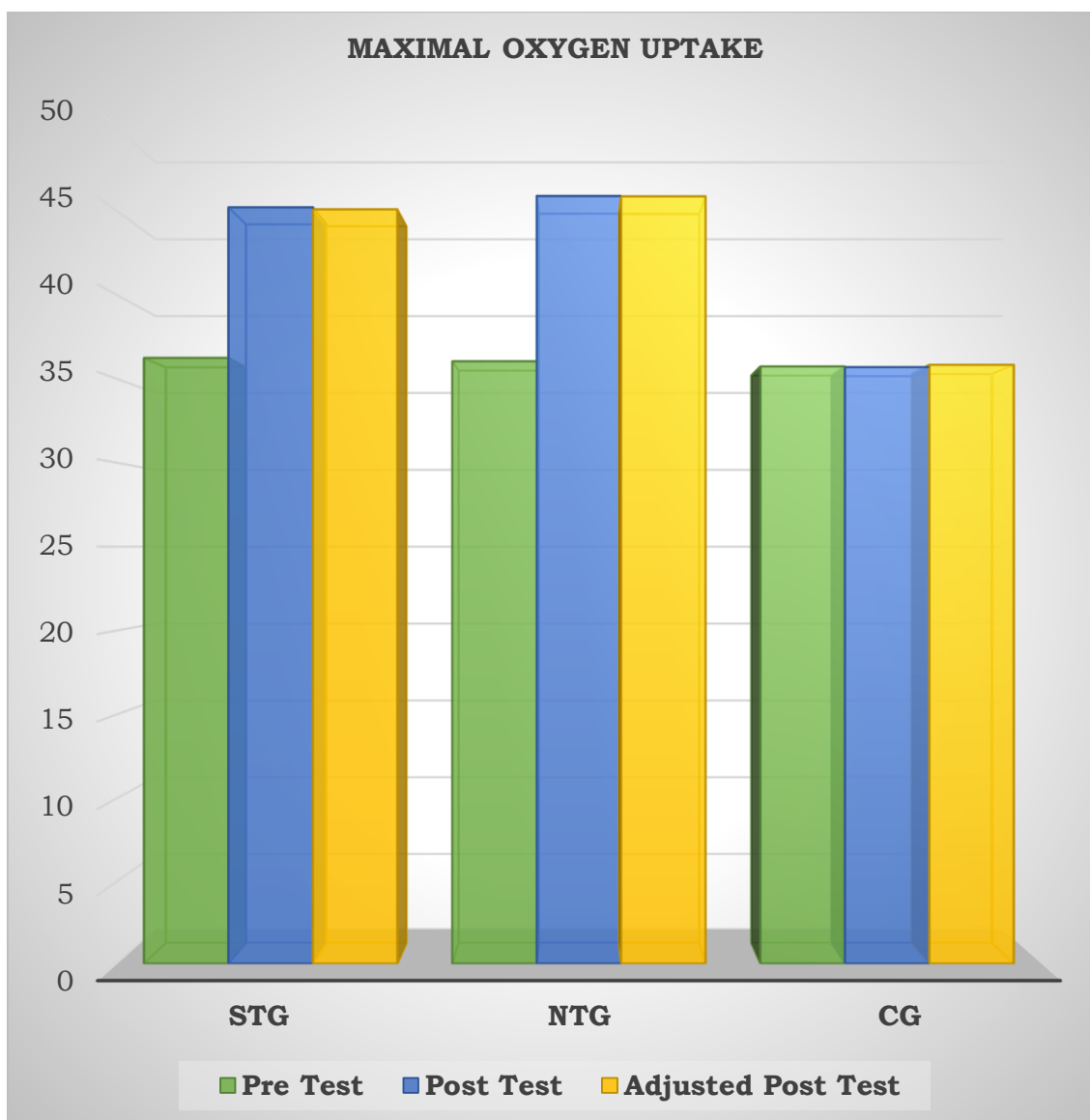
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XVIII proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 1.64. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 1.64.

The pre, post and adjusted test mean values on maximal oxygen uptake were presented through bar diagram for better understanding of the results of this study in figure 10.

Figure – 10

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON MAXIMAL OXYGEN UPTAKE OF
EXPERIMENTAL AND CONTROL GROUPS
(Scores in ml/kg/min)**



4.5.8 RESULTS ON SHORT SERVE

TABLE – XIX

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON SHORT SERVE
(Scores in Points)**

Test	EX 1	EX 2	CG	SV	SS	df	MS	F
Pre Test	59.50	60.00	56.90	B	55.40	2	27.70	1.82
				W	411.40	27	15.24	
Post Test	64.40	66.50	57.00	B	498.07	2	249.03	21.49*
				W	312.90	27	11.59	
Adjusted	64.02	65.86	58.02	B	296.28	2	148.14	19.83*
				W	194.18	26	7.47	
Mean Gain	-4.90	-6.50	-0.10					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table – XIX show that the pretest means of specific skill training, neuromuscular training and control groups were 59.50, 60.00 and 56.90 respectively. The obtained F-ratio 1.82 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 64.40, 66.50 and 57.00 respectively. The obtained F-ratio 21.49 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 64.02, 65.86 and 58.02 respectively. The obtained F-ratio for the adjusted post-test value 19.83 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XX.

TABLE – XX

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON SHORT SERVE
 (Scores in Points)**

EX 1	EX 2	CG	MD	CI
64.02	65.86	-	-1.83	3.17
64.02	-	58.02	6.00	3.17
-	65.86	58.02	7.83	3.17

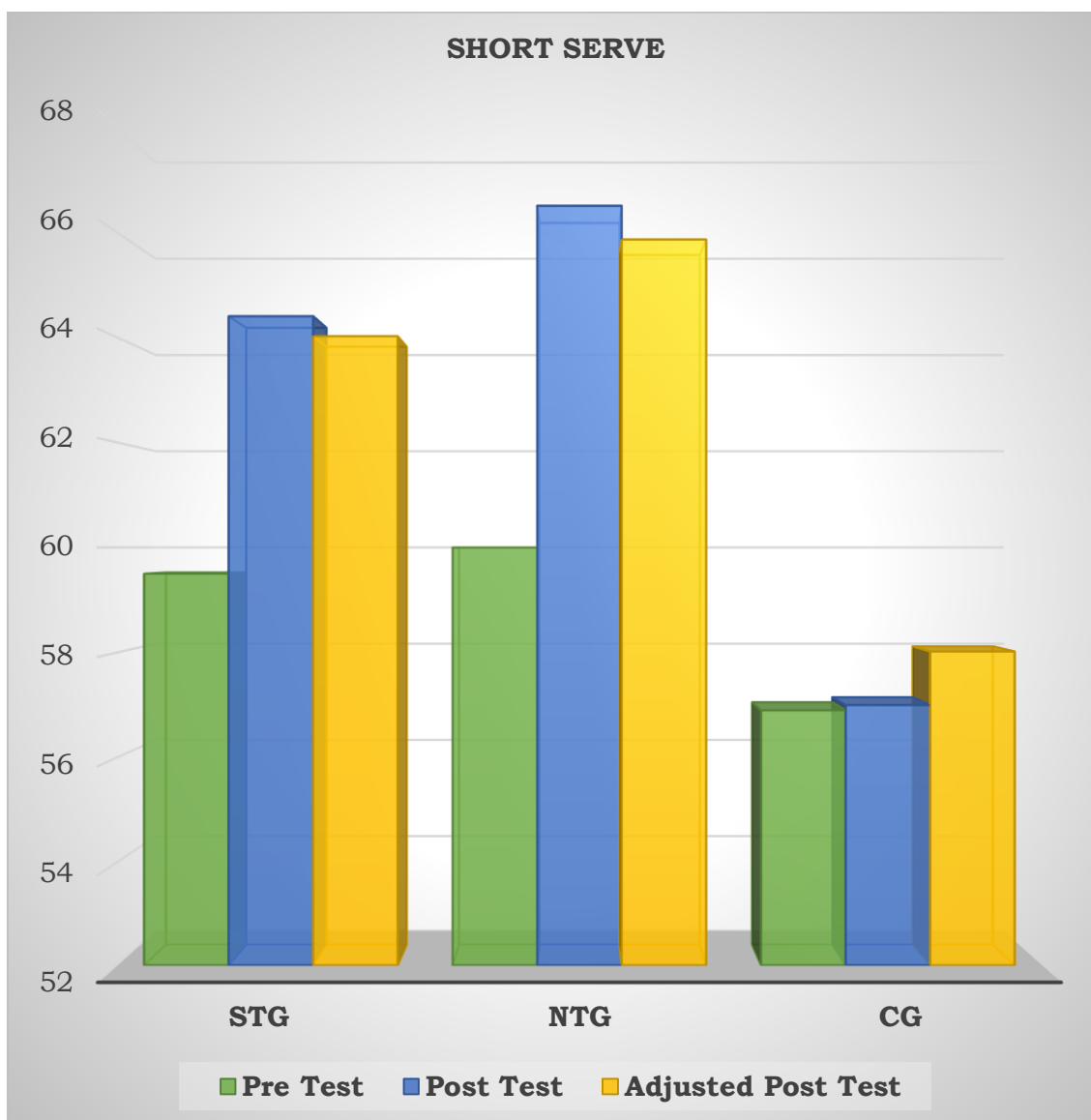
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XX proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 3.17. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 3.17.

The pre, post and adjusted test mean values on short serve were presented through bar diagram for better understanding of the results of this study in figure 11.

Figure – 11

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON SHORT SERVE OF EXPERIMENTAL AND
CONTROL GROUPS
(Scores in Points)**



4.5.9 RESULTS ON LONG SERVE

TABLE – XXI

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON LONG SERVE
(Scores in Points)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	59.60	60.10	57.40	Between	41.27	2	20.63	1.00
				Within	557.70	27	20.66	
Post Test	65.40	65.60	57.00	Between	481.87	2	240.93	11.52*
				Within	564.80	27	20.92	
Adjusted	65.14	65.11	57.75	Between	338.45	2	169.22	9.84*
				Within	447.28	26	17.20	
Mean Gain	-5.80	-5.50	0.40					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table –XXI show that the pretest means of specific skill training, neuromuscular training and control groups were 59.60, 60.10 and 57.40 respectively. The obtained F-ratio 1.00 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 65.40, 65.60 and 57.00 respectively. The obtained F-ratio 11.52 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 65.14, 65.11 and 57.75 respectively. The obtained F-ratio for the adjusted post-test value 9.84 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XXII.

TABLE – XXII

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON LONG SERVE
 (Scores in Points)**

STG	NTG	CG	MD	CI
65.14	65.11	-	0.03	4.80
65.14	-	57.75	7.39*	4.80
-	65.11	57.75	7.36*	4.80

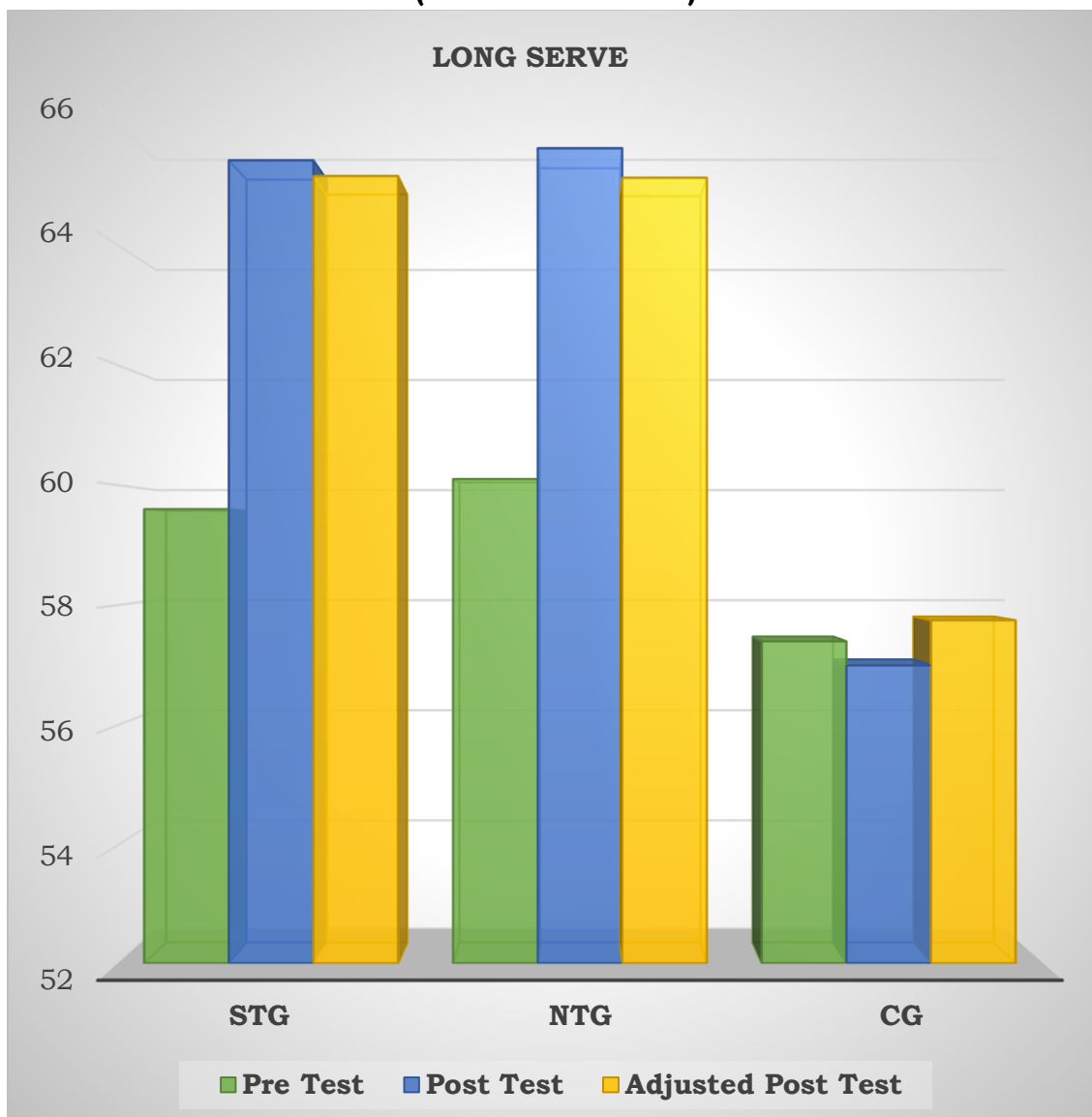
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XXII proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 4.80. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 4.80.

The pre, post and adjusted test mean values on long servewere presented through bar diagram for better understanding of the results of this study in figure 12.

Figure – 12

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON LONG SERVE OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Points)**



4.5.10 RESULTS ON FOREHAND CLEAR

TABLE – XXIII

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON FOREHAND CLEAR
(Scores in Points)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	45.00	46.60	45.20	Between	15.20	2	7.60	1.49
				Within	138.00	27	5.11	
Post Test	55.80	55.60	45.90	Between	640.47	2	320.23	72.72*
				Within	118.90	27	4.40	
Adjusted	56.03	55.22	46.05	Between	607.41	2	303.70	79.88*
				Within	98.851	26	3.80	
Mean Gain	10.80	-9.00	-0.70					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table - XXIII show that the pretest means of specific skill training, neuromuscular training and control groups were 45.00, 46.60 and 45.20 respectively. The obtained F-ratio 1.49 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 55.80, 55.60 and 45.90 respectively. The obtained F-ratio 72.72 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 56.03, 55.22 and 46.05 respectively. The obtained F-ratio for the adjusted post-test value 79.88 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XXIV.

TABLE – XXIV
SCHEFFE’S POST HOC TEST FOR THE DIFFERENCE AMONG
PAIRED MEANS OF EXPERIMENTAL AND CONTROL
GROUPS ON FOREHAND CLEAR
(Scores in Points)

STG	NTG	CG	MD	CI
56.03	55.22	-	0.81	2.26
56.03	-	46.05	9.98*	2.26
-	55.22	46.05	9.17*	2.26

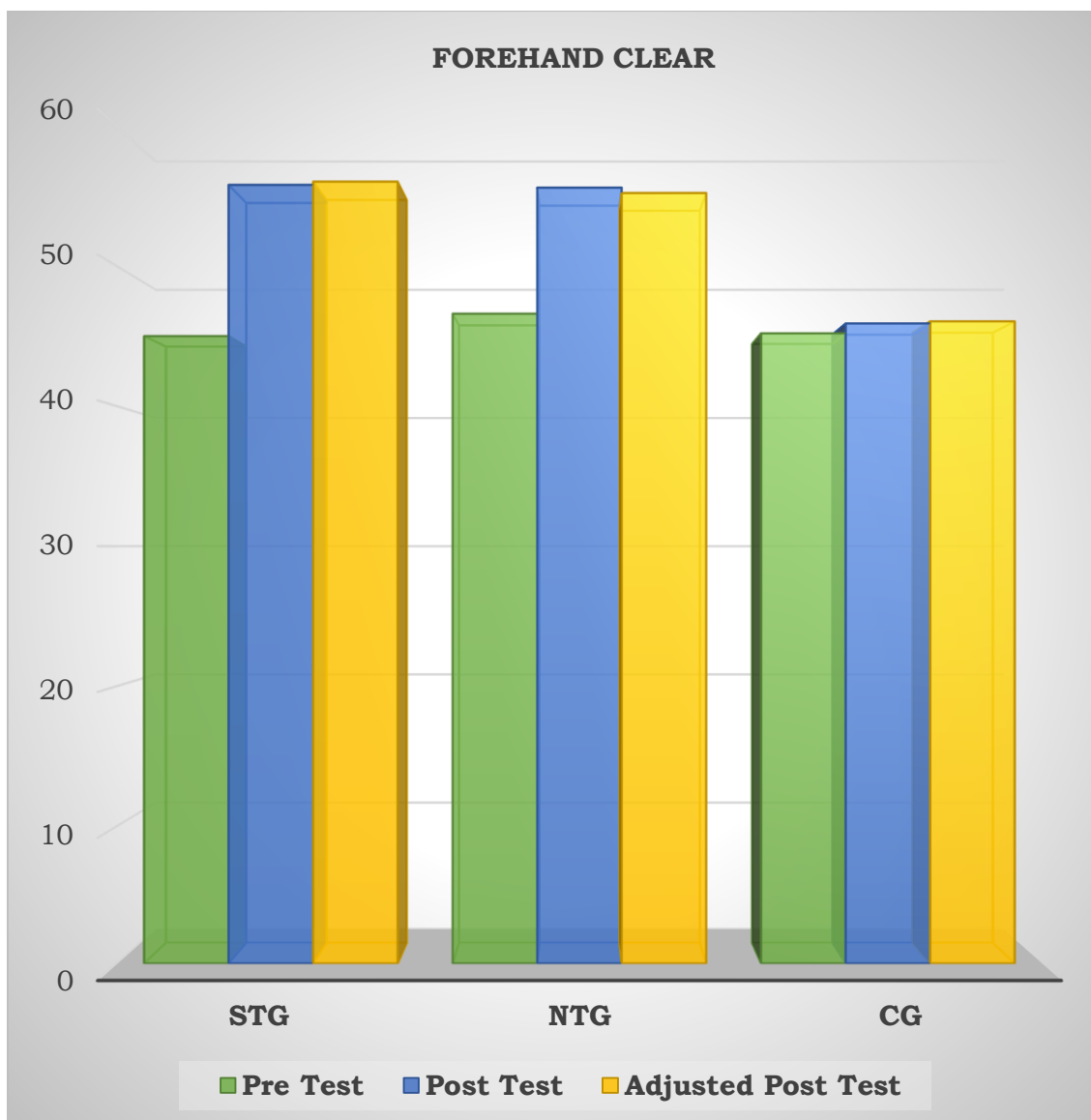
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XXIV proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 2.26. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 2.26.

The pre, post and adjusted test mean values on forehand clear were presented through bar diagram for better understanding of the results of this study in figure 13.

Figure – 13

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON FOREHAND CLEAR OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Points)**



4.5.11 RESULTS ON BACK HAND CLEAR

TABLE – XXV

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON BACK HAND CLEAR
(Scores in Points)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	45.80	47.30	45.90	Between	14.07	2	7.03	1.60
				Within	118.60	27	4.39	
Post Test	56.20	57.00	44.90	Between	915.80	2	457.90	47.10*
				Within	262.50	27	9.72	
Adjusted	56.30	56.81	44.99	Between	872.14	2	436.07	43.96*
				Within	257.92	26	9.92	
Mean Gain	-10.40	-9.70	1.00					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table – XXV show that the pretest means of specific skill training, neuromuscular training and control groups were 45.80, 47.30 and 45.90 respectively. The obtained F-ratio 1.60 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 56.20, 57.00 and 44.90 respectively. The obtained F-ratio 47.10 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 56.30, 56.81 and 44.99 respectively. The obtained F-ratio for the adjusted post-test value 43.96 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XXVI.

TABLE – XXVI

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON BACK HAND CLEAR
 (Scores in Points)**

STG	NTG	CG	MD	CI
56.30	56.81	-	-0.51	3.65
56.30	-	44.99	11.32*	3.65
-	56.81	44.99	11.82*	3.65

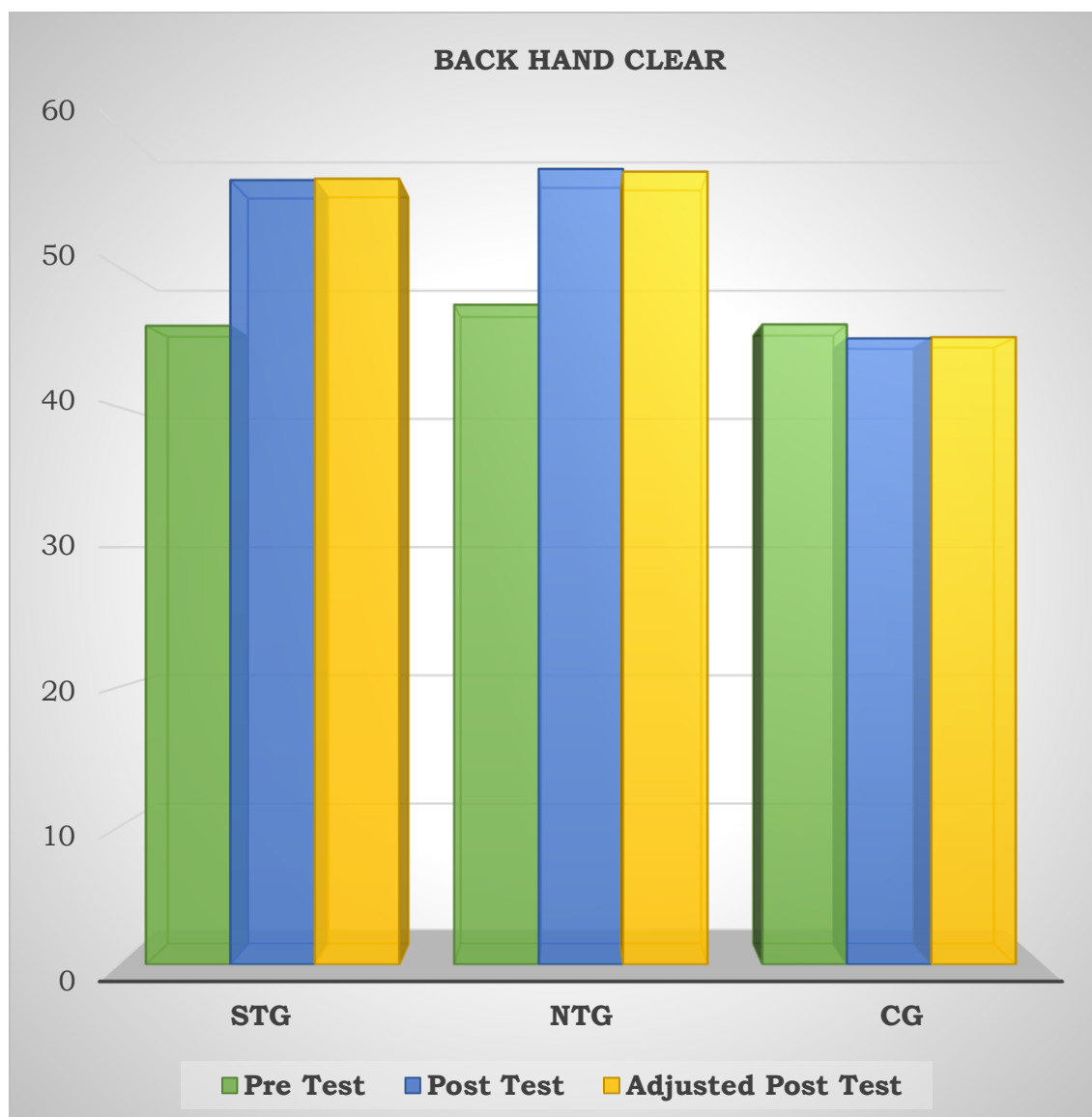
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XXVI proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 3.65. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 3.65.

The pre, post and adjusted test mean values on back hand clear were presented through bar diagram for better understanding of the results of this study in figure 14.

Figure – 14

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON BACK HAND CLEAR OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Points)**



4.5.12 RESULTS ON VOLLEYING ABILITY

TABLE – XXVII

**COMPUTATION OF ANALYSIS OF COVARIANCE FOR THE PRE, POST
AND ADJUSTED POST TEST ON VOLLEYING ABILITY
(Scores in Points)**

Test	STG	NTG	CG	SV	SS	df	MS	F
Pre Test	12.00	12.20	13.20	Between	8.27	2	4.13	1.48
				Within	75.20	27	2.79	
Post Test	15.60	16.10	12.70	Between	67.40	2	33.70	13.91*
				Within	65.40	27	2.42	
Adjusted	15.66	16.13	12.61	Between	66.49	2	33.24	13.46*
				Within	64.24	26	2.47	
Mean Gain	-3.60	-3.90	0.50					

*Significant at 0.05 level of confidence for df (2, 27) and (2, 26) are 3.35 and 3.37 respectively

The statistical analysis from the table –XXVII show that the pretest means of specific skill training, neuromuscular training and control groups were 12.00, 12.20 and 13.20 respectively. The obtained F-ratio 1.48 for the pre-test was lesser than the required table value of 3.35 for the degree of freedom 2 and 27 required for significant at 0.05 level. This proved that there was no significant difference between the experimental and control groups indicating that the process of randomization of the groups was perfect while assigning the subjects to groups.

The post-test means of specific skill training, neuromuscular training and control groups were 15.60, 16.10 and 12.70 respectively. The obtained F-ratio 13.91 for the post-test was greater than the required table value of 3.35 for the degree of freedom 2 and 57 required for significant at 0.05 level. This proved that the differences between the posttest means of the subjects were significant.

The adjusted post-test means of specific skill training, neuromuscular training and control groups were 15.66, 16.13 and 12.61 respectively. The obtained F-ratio for the adjusted post-test value 13.46 was greater than the required table value of 3.37 for the degree of freedom 2 and 26 required for significant at 0.05 level. This proved that the differences between the adjusted post-test means of the subjects were significant.

Hence, the above analysis of the study indicates that there was a significant difference among the adjusted post-test means of specific skill training, neuromuscular training and control group. Further, to determine which of the three paired means had a significant difference, the Scheffe's was applied as post hoc test and the results are presented in Table XXVIII.

TABLE – XXVIII

**SCHEFFE'S POST HOC TEST FOR THE DIFFERENCE AMONG
 PAIRED MEANS OF EXPERIMENTAL AND CONTROL
 GROUPS ON VOLLEYING ABILITY
 (Scores in Points)**

STG	NTG	CG	MD	CI
15.66	16.13	-	0.48	1.82
15.66	-	12.61	3.05*	1.82
-	16.13	12.61	3.53*	1.82

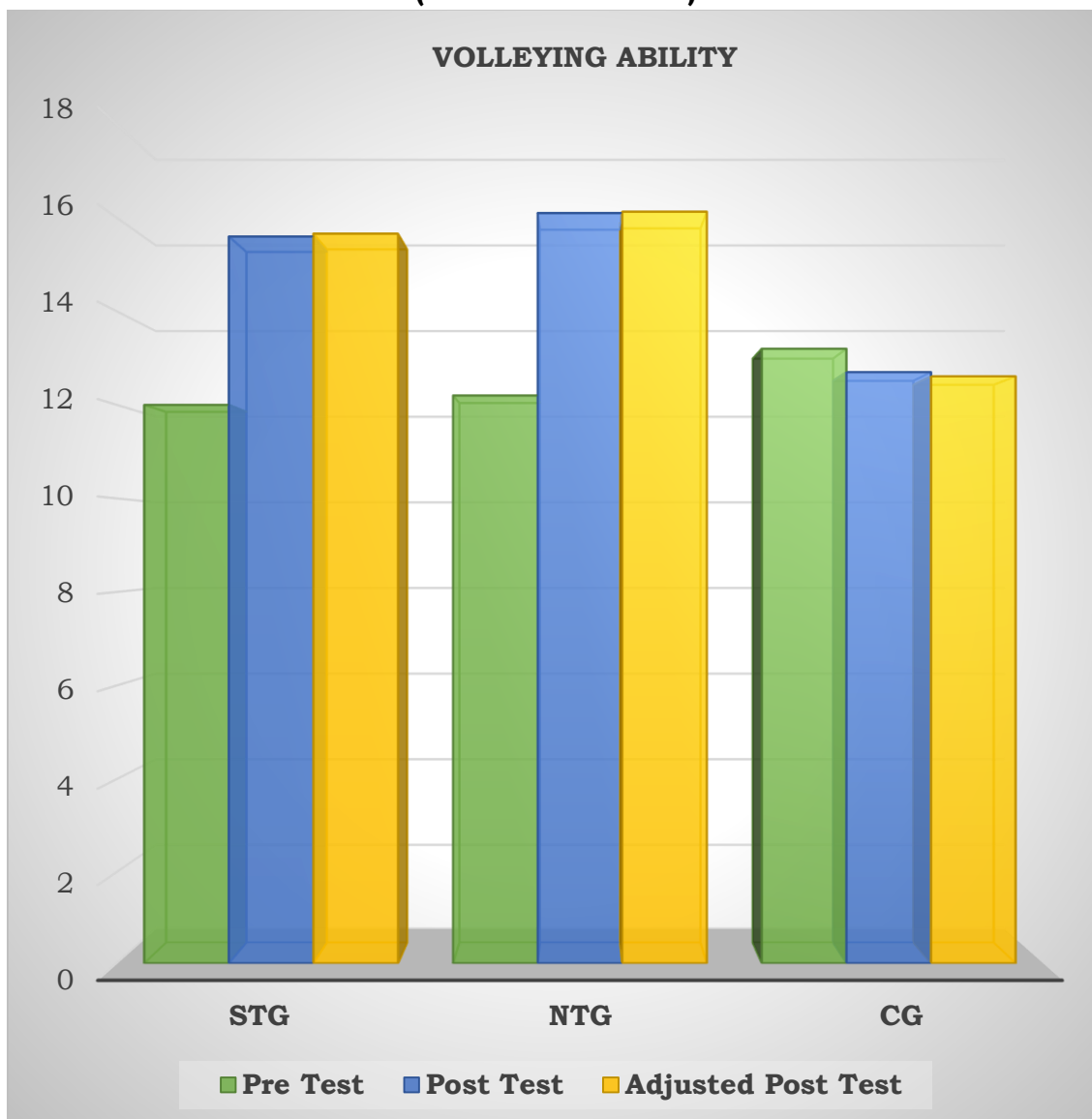
*Significant at 0.05 level of confidence

The multiple mean comparison showed in Table XXVIII proved that there were significant differences exists between the adjusted means of specific skill training, neuromuscular training and control group as the mean difference were greater than the obtained confidence interval 1.82. There was no significant difference between specific skill training and neuromuscular training as the mean difference was lesser than the obtained confidence interval 1.82.

The pre, post and adjusted test mean values on back hand clearwere presented through bar diagram for better understanding of the results of this study in figure 15.

Figure – 15

**BAR DIAGRAM SHOWING THE PRE, POST AND ADJUSTED POST
TEST MEAN VALUES ON VOLLEYING ABILITY OF EXPERIMENTAL
AND CONTROL GROUPS
(Scores in Points)**



4.6 DISCUSSION ON FINDINGS

From the results it was proved that there was a significant improvement on physical fitness variables such as agility, flexibility and leg explosive power due to specific skill training and neuromuscular training. This results were in line with the results of Eng Hoe Wee, et al., (2017) founded high intensity intermittent badminton multi-shuttle feeding training significant improvements in leg reactive strength and agility in experimental group. Further, Srinivasan and Sathishkumar, (2016) concluded that there was significant improvement due to ladder training on agility, explosive power school volleyball players. Fernandez-Fernandez, et al., (2018) examined the 5-week neuromuscular training (NMT) implemented before or after a tennis session produce positive effects from pretest to posttest measures in sprint, change of direction capacity, as well as upper-body power. Dong et al., (2018), founded RIT was more effective than SR to improve the on-court agility of novice badminton players. Zemkova, &Hamar, (2018), Neuromuscular training in young athletes improves performance and decreases the risk of injuries during sports activities. These effects are primarily ascribed to the enhancement of muscle strength and power but also balance, speed and agility.

From the results it was proved that there was no significant improvement on physical fitness variables such as speed and arm strength due to specific skill training and neuromuscular training. This

results were in line with the results of Fereshteh Shahidi, et al, (2012) founded resistance training was probably effective for improving lower-body explosive power, lower-body muscle endurance, running speed, maximum lower-body strength, and abdominal muscle endurance in 16-18 Years Old male soccer players.

From the results it was proved that there was a significant improvement on physiological variables such as anaerobic power and maximal oxygen uptake due to specific skill training and neuromuscular training. This results were in line with the results of Mert Aydogmuş et al., (2015) studied both badminton-specific training and badminton match six times per week for 12 weeks increased aerobic fitness level. Further, Eng Hoe Wee, et al., (2017) founded high intensity intermittent badminton multi-shuttle feeding training significant improvements in $VO_2\text{max}$ and mean power in experimental group. Further, In accordance with our results, Ghosh et al. (1993) found that a three weeks specific training increased $VO_2\text{ max}$ from 43.8 ml/kg/min to 46.4 ml/kg/min in five women badminton players. ACSM (2000) have recommended improving $VO_2\text{ max}$ aerobic exercise 3-5 times per week for 20–60 minutes per session, at an intensity that maintains the heart rate between 65-90% of the maximum heart rate. In this study, training duration and frequency were enough to improve aerobic fitness level. Metabolic demands of badminton match are related mainly to aerobic energy metabolism although characterized explosive actions such as lunging, jumping, and

powerful strokes. This result demonstrated that badminton specific training produced a similar increase to badminton match at level of VO₂ max in adolescent players.

From the results it was proved that there was a significant improvement on skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability due to specific skill training and neuromuscular training. This result were in line with the results of Ibrahim Hamed Ibrahim Hassan, (2017) examined eight weeks core stability training provides an improvement for maintained optimum lower limbs dynamic balance and increased the performance level of smash stroke in young badminton players. Mazin Ahmad and Sarahang Abdullah, (2014) studied whether distributor and intensive exercises conferred any greater alterations in accuracy of high and low serve skills performance. Researchers concluded the intensive exercise group reported improvements in all tests better than distributor exercise group. Then, different training styles appear to lead to worthwhile growths in high and low and serving accuracy test with badminton players. Acharya and James (2004) studied proprioceptive training as a measure of skill improvement among novice badminton players. It was concluded proprioceptive training is not only for rehabilitation but also for improvement of skills and sport performance. Frohlich, Felder & Reuter, (2014) founded plyometric strength training to be important to include short-term PT in in-season

preparation in order to improve complex badminton-specific dynamic performance (smash-jumping).

4.7 DISCUSSION ON HYPOTHESES

First hypotheses stated that it was hypothesized that there would be a significant improvement on selected physical physiological and skill related variables due to specific skill training among state level male junior badminton players. Results proved that there was a significant improvement on physical fitness variables such as agility, flexibility and leg explosive power and physiological variables such as anaerobic power and maximal oxygen uptake and skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability. However, there was no significant improvement on physical fitness variables such as speed and arm strength. Hence the hypotheses was accepted for the physical fitness variables such as agility, flexibility and leg explosive power and physiological variables such as anaerobic power and maximal oxygen uptake and skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability at 0.05 level of confidence. The hypotheses were rejected for the variables for the physical fitness variables such as speed and arm strength at 0.05 level of confidence.

Second hypotheses stated that it was hypothesized that there would be a significant improvement on selected physical physiological and skill related variables due to neuromuscular training among state

level male junior badminton players. Results proved that there was a significant improvement on physical fitness variables such as agility, flexibility and leg explosive power and physiological variables such as anaerobic power and maximal oxygen uptake and skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability. However, there was no significant improvement on physical fitness variables such as speed and arm strength. Hence the hypotheses was accepted for the physical fitness variables such as agility, flexibility and leg explosive power and physiological variables such as anaerobic power and maximal oxygen uptake and skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability at 0.05 level of confidence. The hypotheses was rejected for the variables for the physical fitness variables such as speed and arm strength at 0.05 level of confidence.

Third hypotheses stated that it was hypothesized that specific skill training would be better in improving skill related variables of state level male junior badminton players than neuromuscular training. Results proved that specific skill training and neuromuscular training were equal in improving all the selected variables. Hence the hypotheses were rejected at 0.05 level of confidence.

Fourth hypothesis stated that it was hypothesized that neuromuscular training would be better in improving physical and

physiological variables of state level male junior badminton players than specific skill training. Results proved that specific skill training and neuromuscular training were equal in improving all the selected variables. Hence the hypotheses were rejected at 0.05 level of confidence.

CHAPTER - V

SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

Junior players are required to have a good physical fitness, as well as physiological profiling and stroke production that will enable successful performance at the competitive level. The aims and objective of the present study was to examine the player's physical fitness, physiological responses and simultaneously to measure the skills related variables among state level male junior badminton player. It is important to ascertain the most efficacious method for enhancing fitness performance and also to bring the player to the next level and reduce the fatigue. Further, not much research has been completed on the physiological aspects of badminton. This research aim was to examine the impact of specific skill and neuromuscular training on selected physical physiological and skill related variables among state level male junior badminton players.

To achieve the purpose of the study, thirty (N=30) state level junior male badminton players were selected randomly in the age group of 16 and 18 years Chennai. They were assigned into three group's namely experimental group I (specific skill training), experimental group II (neuromuscular training) and group III acted as Control Group. Experimental groups underwent training for a period of 12 weeks. The data collected from experimental group and control groups on selected physical physiological and skill related variables in relation to and adjusted post test scores were subjected to statistical analysis using

paired 't' test to analyse the significant difference if any between pre-test, post-test. Further, Analysis of Covariance (ANCOVA) to find out the significance among the mean differences, whenever the 'F' ratio for adjusted test was found to be significant, Scheffe's post hoc test was used. In all cases 0.05 level of significance was fixed to test hypotheses.

5.2 CONCLUSION

The following conclusions have been derived on the basis of the limitation and delimitation.

1. It was concluded that there was a significant improvement on selected physical fitness variables such as agility, flexibility and leg explosive power due to specific skill training and neuromuscular training.
2. It was concluded that there was no significant improvement on physical fitness variables such as speed and arm strength due to specific skill training and neuromuscular training.
3. It was concluded that there was a significant improvement on physiological variables such as anaerobic power and maximal oxygen uptake due to specific skill training and neuromuscular training.
4. It was concluded that there was a significant improvement on skill related variables such as short serve, long serve, forehand clear, back hand clear and volleying ability due to specific skill training and neuromuscular training.

5.3 RECOMMENDATIONS

The following recommendations have been derived on the basis of the study for practitioners.

1. It was found that specific skill training and neuromuscular training were useful for improving the performance badminton players.
2. It was found the specific skill training and neuromuscular training were useful for improving the physical fitness level of badminton players.
3. It was found the specific skill training and neuromuscular training were useful for improving the physiological fitness level of badminton players.
4. The badminton association of India and private badminton clubs may include the specific skill training and neuromuscular training as a part of training schedule badminton players.

5.4 SUGGESTION FOR FURTHER RESEARCH

During the course of the research study, the investigator came across a number of ideas, based on which the following suggestions are made for further research in this area.

1. Similar study can be undertaken to find out the changes on psychological variables.

2. Similar study can be undertaken for elite level of badminton players.
3. Similar study can be undertaken for rural and urban badminton players.
4. This type of study can be undertaken on different age groups.
5. Since the research was selected on two experimental groups, more experimental groups can be compared for badminton players.
6. Similar study can be conducted on other physiological, psychological and life skill variables also.
7. Similar study may be conducted for the extension period of experimentation by selecting a large sample.
8. The present study needed to be strengthened or support by more relevant research studies.

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APPENDIX A

APPENDIX B

APPENDIX C**Raw Scores on Speed**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	9.18	9.02	8.36	8.24	9.23	9.2
2	9.52	9.22	9.12	8.82	8.21	8.15
3	8.9	8.61	8.72	8.15	8.92	8.86
4	9.45	9.04	9.36	8.32	9.65	9.56
5	9.45	9.08	8.41	8.25	8.41	8.39
6	8.32	8.16	9.26	8.26	9.56	9.48
7	9.12	8.89	9.23	8.35	8.72	8.68
8	9.4	9.06	8.5	8.28	9.41	9.35
9	9.25	8.79	8.51	8.35	8.21	8.14
10	8.52	8.42	8.32	8.15	9.84	9.77

APPENDIX D

Raw Scores on Agility

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	11.54	10.9	12	11.6	12.9	12.8
2	12.1	10.2	12	11.3	13	13
3	12.9	11.2	11.6	11	12.9	12.8
4	13.45	11.4	11.7	10.9	11.4	11.2
5	12.9	9.2	10.23	12.5	12.9	12.8
6	11.4	10.1	12.4	11.9	13	12.3
7	12.7	11.6	12.4	11.7	11.5	11.5
8	11.1	9.5	12.6	12.1	10.36	11
9	13.7	12.1	12.1	11.6	12.9	12.9
10	13.4	12	12.3	11.9	13	13

APPENDIX E

Raw Scores on Flexibility

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	23.4	24.6	22.1	26.8	22.6	22.6
2	23.4	25.6	23.5	26.5	23.4	23.4
3	23.2	25.4	24.6	27.6	25.6	25.4
4	22.6	26.3	25.8	25.4	24.3	24.6
5	26.3	24.6	26.5	26.8	24.3	24.5
6	22.4	25.8	25.4	28.2	22.5	22.6
7	22.4	24.8	24.2	27.1	21.3	21.4
8	23.1	26.5	23.1	26.3	26.4	27.1
9	22.1	24.6	21.6	24.2	25.4	26.2
10	22.6	24.8	24.1	25.3	23.5	22.8

APPENDIX F**Raw Scores on Arm strength**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	40	43	42	46	45	45
2	42	45	42	47	41	41
3	45	48	41	47	42	43
4	43	47	43	48	51	49
5	51	52	45	51	41	42
6	42	46	46	50	45	44
7	41	42	44	50	48	48
8	43	45	45	48	45	44
9	45	44	42	46	42	41
10	41	43	41	47	51	51

APPENDIX G**Raw Scores on Leg explosive power**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	24	27	22	23	25	25
2	26	28	22	27	21	21
3	26	27	21	25	22	26
4	24	26	23	28	26	24
5	22	25	25	27	21	22
6	26	28	26	28	25	23
7	25	27	24	27	21	22
8	25	27	25	29	25	24
9	24	26	22	24	22	21
10	21	24	21	26	24	23

APPENDIX H**Raw Scores on Aerobic power**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	1324	1365	1245	1425	1243	1242
2	1345	1426	1325	1436	1246	1242
3	1232	1423	1342	1462	1241	1241
4	1241	1365	1234	1453	1235	1235
5	1234	1348	1262	1456	1324	1324
6	1256	1365	1325	1423	1241	1242
7	1342	1425	1354	1432	1256	1257
8	1235	1423	1345	1462	1234	1325
9	1245	1365	1362	1452	1324	1321
10	1262	1395	1345	1463	1325	1325

APPENDIX I**Raw Scores on Max O2**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	36.58	42.13	36.52	48.32	34.26	34.29
2	36.45	45.35	36.35	44.56	36.35	36.34
3	36.46	46.25	36.45	46.52	36.85	36.85
4	36.42	43.25	35.23	44.38	35.46	35.42
5	35.85	48.2	35.46	45.62	36.24	36.24
6	35.64	47.6	36.45	46.58	36.45	35.98
7	36.45	45.62	36.45	47.56	35.34	35.34
8	35.62	45.23	36.32	44.58	35.23	35.26
9	36.45	43.25	35.46	45.36	34.95	34.99
10	36.45	45.23	35.74	45.29	36.12	36.21

APPENDIX J**Raw Scores on Short serve**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	65	69	64	71	56	56
2	56	63	58	68	63	66
3	58	62	62	69	58	57
4	62	66	62	67	62	61
5	57	59	56	65	61	61
6	62	66	58	66	54	56
7	62	66	62	71	58	57
8	63	65	64	66	50	51
9	52	66	56	68	54	53
10	58	62	58	71	51	52

APPENDIX K**Raw Scores on Long serve**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	64	72	63	70	56	56
2	55	71	57	59	65	66
3	59	65	69	69	57	57
4	62	67	62	67	62	61
5	57	59	56	65	62	61
6	62	66	54	66	54	56
7	64	61	62	71	59	57
8	63	65	64	59	50	51
9	52	66	56	59	58	53
10	58	62	58	71	51	52

APPENDIX L**Raw Scores on Fore hand clear**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	45	54	48	59	49	49
2	48	55	47	58	47	47
3	46	56	46	54	48	48
4	47	54	45	52	46	46
5	45	56	47	54	45	45
6	47	59	45	54	45	47
7	45	54	44	56	44	46
8	41	54	48	57	42	43
9	40	59	47	57	41	42
10	46	57	49	55	45	46

APPENDIX M**Raw Scores on Back hand clear**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	47	54	51	59	49	51
2	48	55	47	61	47	47
3	46	56	46	54	48	48
4	47	54	47	52	46	46
5	45	56	49	54	45	42
6	48	59	45	65	46	44
7	45	54	44	56	46	46
8	46	58	48	57	42	41
9	40	59	47	57	45	42
10	46	57	49	55	45	42

APPENDIX N**Raw Scores on Volleying ability**

	Ex I		Ex II		CG	
	Pre	Post	Pre	Post	Pre	post
1	10	18	10	17	15	10
2	12	18	14	15	14	14
3	14	14	15	17	15	14
4	12	17	12	18	14	14
5	12	15	11	14	14	15
6	14	16	10	16	10	13
7	13	14	12	16	10	10
8	12	15	12	16	14	14
9	11	15	14	17	14	12
10	10	14	12	15	12	11



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Efficacy of specific skill and neuromuscular training on speed and explosive power among badminton players

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Abstract

The purpose of the study was to find out the efficacy of specific skill and neuromuscular training on speed and explosive power among badminton players. To achieve the purpose of this study forty-five (N= 45) school level badminton players were selected as subjects, who were members of badminton clubs, in Chennai. The age group of the subjects were between 15 to 17 years. The subjects were randomly divided into three groups consists of fifteen subjects. Group I underwent neuromuscular training and Group II underwent specific skill training and group III acted as control group. The investigator selected speed and leg explosive power as variables for this study. Pre and post test random group design was followed in this study. The data obtained from initial and final scores were statistically analysed for test of significance using Analysis of Covariance (ANCOVA). In all cases the significance level fixed was 0.05 levels, which was considered as appropriate. The results existing proved that there was a significant influence due to the neuromuscular training and specific skill training on speed and leg explosive power among school level badminton players.

Keywords: Badminton, neuromuscular training, specific skill training, speed and leg explosive power

Introduction

Badminton is a highly complex sport and this presents great challenges for players and coaches of all levels. An individual rally is a series of demanding movements performed using a movement pattern which is unique compared with any other sport. Rally length is often short (average for elite players is around 6-8 seconds) and, consequently, performed at very high intensity. However, players must also be prepared for long rallies. Rallies are interspersed with short rest

Periods (typical duration around 15 seconds) which allow partial recovery from the previous rally, however, competitive matches may last at least 45 minutes. So, badminton is a combination of speed (anaerobic fitness) in rallies and endurance (aerobic fitness) to allow sustained efforts and to promote recovery between rallies. Great strength, power, agility and flexibility are also required. All of these fitness components should form part of a player's fitness training. Additionally, the development of tactical and technical elements is, of course, also vital.

Training needs to be varied in order to enhance Leg power is an important component in badminton in that it results in the player being able to move quickly and explosively to the shuttle in various directions and to jump high to play overhead strokes. Greater leg power results in a greater acceleration and faster speed when lifting off the floor when moving, or jumping to the shuttle. According to Omosegaard (1996) [2], an explosive player will typically be able to jump high, change direction quickly and will generally appear to be swift and mobile on the badminton court. Leg power is therefore a combination of co-ordination and muscular properties.

Speed is needed in badminton for moving to and from the shuttle, and the ability to cover short distances quickly would be a great advantage for the badminton player (Todd and Mahoney, 1995) [5]. If a player needs to increase movement speed, then that needs to be achieved in many varied circumstances on and off the court. Neuromuscular training has been defined as multi-intervention programs that combine balance, strength, plyometric, agility, and sport-specific exercises (Coughlan and Caulfield, 2007) [1].

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The physical fitness of a badminton player can be the decisive determinant of success during a tournament, and if a player wishes to achieve success in competition, an improvement in physical fitness needs to be emphasis. At this perspective, the aim of our study was to investigate the efficacy of specific skill and neuromuscular training on speed and explosive power among badminton players.

Methodology

To achieve the purpose of this study forty-five (N=45) school level badminton players were selected as subjects, who were members of badminton clubs, in Chennai. The age group of the subjects were between 15 to 17 years. The subjects were randomly divided into three groups consists of fifteen subjects. Group I underwent neuromuscular training and

Group II underwent specific skill training and group III acted as control group for the period of ten weeks. The investigator selected speed and leg explosive power as variables and tested with 50 meter dash and vertical jump test respectively for this study. Pre-test and post-test random group design was followed in this study. The data obtained from initial and final scores were statistically analysed for test of significance using Analysis of Covariance (ANCOVA). In all cases the significance level fixed was 0.05 levels, which was considered as appropriate.

Result and discussion

The statistical analysis of comparing the initial and final score of speed among experimental and control group.

Table 1: Analysis of co-variance of speeds among experimental and control groups (Scores in seconds)

	Exe Group-I	Exe Group-II	Control Group	Source of variance	Sum of variance	DF	Mean squares	Obtained F-ratio
Pre Test Mean	7.30	7.32	7.33	Between	0.00	2	0.00	0.24
				within	0.37	42	0.01	
Post Test Mean	7.21	7.23	7.30	Between	0.06	2	0.03	5.11*
				Within	0.25	42	0.01	
Adjusted Post Test Mean	7.22	7.23	7.29	Between	0.04	2	0.02	16.14*
				within	0.05	41	0.00	
Mean Diff	-0.10	-0.09	-0.03					

*Significant (table F ratio at 0.05 level of confidence for 2 and 42(DF) =3.22, 2 and 41(DF) =3.23)

As shown in table 1, the obtained F value on the scores of pre-test means 0.24, which was lesser than the required table value. Hence, it was insignificant at 0.05 levels. The obtained F value on post-test means was 5.11, which was greater than required table value of 3.22 and was significant at 0.05 levels. Taking into consideration of the pre and post-test means adjusted post-test means were determined and analysis of covariance was done and the obtained F value 16.14 was greater than the required value of 3.23 and hence it was accepted that there was significant difference among the treated groups. Since significant difference was recorded, the results were subjected to post hoc analysis using Scheffe's Confidence interval test. The result was presented in the table-2.

Table 2: Scheffe's Confidence Interval test scores on speed

Exp. Group-I	Exp. Group-II	Control group	Mean difference	Required CI
7.22	7.23		0.02	0.03
7.22		7.29	0.07*	
	7.23	7.29	0.05*	

*Significant

The post hoc analysis of obtained ordered adjusted means proved that there was significant difference existed between neuromuscular and specific skill training and control group and there was no significant difference between treatment groups.

Table 3: Analysis of covariance of leg explosive power among experimental and Control group (Scores in Numbers)

	Exp. Group-I	Exp. Group-II	Control group	Source of variance	Sum of squares	DF	Mean squares	Obtained F-ratio
Pre Test Mean	16.53	19.80	19.40	Between	95.24	2	47.62	1.51
				within	173.73	42	4.14	
Post Test Mean	19.87	22.93	18.87	Between	134.71	2	67.36	14.26*
				within	198.40	42	4.72	
Adjusted Post Test Mean	21.64	21.87	18.15	Between	124.65	2	62.32	37.72*
				within	67.74	41	1.65	
Mean Differ	3.33	3.13	-0.53					

*significant table F-ratio at 0.05 level of confidence for 2 and 42 (DF) =3.22, 2 and 41(DF) =3.23

As shown in table-2, the obtained F value on the scores of pretest means 1.51, which was lesser than the required table value, hence, it was insignificant at 0.05 levels. The obtained F value on posttest means was 14.26, which was greater than the required table value of 3.22 and was significant at 0.05 levels. Taking into consideration of the pre and posttest means adjusted means were determined and analysis of covariance

was done and the obtained F value 37.72 was greater than the required value of 3.23 and hence it was accepted that there was significant differences among the treated groups. Since significant difference was recorded, the results were subjected to post hoc analysis using scheffe's confidence interval test. The results were presented in table -2.

Table 4: Scheffe's Confidence Interval Test Scores on leg explosive power

				Required CI
Strength training	Court drills training	Control group	Mean difference	1.18
21.64	21.87		0.23	
21.64		18.15	3.49*	
	21.87	18.15	3.72*	

*Significant

The post hoc analysis of obtained ordered adjusted means proved that there was significant difference existed between neuromuscular and specific skill training and control group and there was no significant difference between treatment groups.

Conclusion

The results of this study provide evidence that ten weeks of specific skill and neuromuscular training on Speed and leg explosive power was significantly improved due to neuromuscular and specific skill training among badminton players. The effects of training programs specifically targeted on speed and leg explosive power for the enhancement of the badminton playing ability. Badminton at the highest level puts a great demand on leg strength (Omosegaard, 1996) ^[2]. Speed is needed in badminton in moving to and from the shuttle. Speed on a badminton court is not only a question of being in good physical condition (Omosegaard, 1996) ^[2]. According to Roetert et al. (1996) ^[4], a vital aspect of sports such as badminton is the ability of the player to exert muscular force at high speed. Many sports require a generation of high forces and power outputs (Reilly et al., 1990) ^[3].

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Research article

EFFECT OF SPECIFIC SKILL AND NEUROMUSCULAR TRAINING ON SELECTED SKILL PERFORMANCE VARIABLE AMONG STATE LEVEL MALE BADMINTON PLAYERS

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Abstract

The purpose of the study was to examine the effect of specific skill and neuromuscular training on selected skill performance variables among state level male badminton players. To achieve the purpose of the study thirty (N=30) state level male badminton players were selected randomly in the Chennai, city. They would be assigned into three group's namely experimental group I (Specific skill training), experimental group II (Neuromuscular training) and group III acted as Control Group. Their ages ranges from 17 and 19 years. They are selected only badminton players. After analyzing the various factors associated with the presented in this study. The following skill performance variable such as fore hand and back hand clear were tested using Poole fore hand and back hand clear test. The collected data were analysed statistically by ANCOVA was used. From the analysis of data it was proved that there were significant improvement on fore hand and back hand clear among state level male Junior Badminton Players.

Key Words: Specific skill Training, Neuromuscular Training, Fore Hand clear and Back Hand clear.

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INTRODUCTION

"The Game of Badminton is wonderful sport that requires eye-hand coordination, quick movements, striking and change of

direction in pursuit of the shuttle cock. Badminton is a power game requiring quick and powerful movements to all directions to return the shuttle cock to the

opponents' side of the court". According to Groppel and Roetert (1992) and Lei *et al.* (1993), the physical requirements of racquet sports demand efficiency in a number of fitness components. To be able to execute advanced strokes or compete effectively against progressively stronger opponents, a player would need to develop higher levels of the basic physical qualities, such as strength, power, muscular endurance, flexibility, coordination and agility.

To play the game effectively, a player can use various drills and strokes. Thus it is very important for a player to determine in advance which stroke his opponent player will use and where the shuttle will land on his court. He should always remain prepared and be very alert on the court. The player must improve the sprints, leaps, lunges, twists, turns, stretches and hitting actions. A successful player must move quickly when necessary but changes in direction are equally important in the game due to the nature of the movements required in a rally. While some people seem to be naturally fast and agile, these are both skills that can be acquired.

According to Singh (1984) Sports training aims is to improve the fitness of a person and promoting the acquisition of basic movement skills. To achieve this, training should have some basic principles and the most important basic principle of training is overload. Most Physiological systems can adapt to functional demands that exceed these loads encountered in normal daily life. In order to find out the outcome of specific skill and neuromuscular training on

selected skill performance variables among state level male badminton players, the scholar being a badminton player has selected this area for his research.

STATEMENT OF THE PROBLEM

The purpose of the study was to examine the effect of specific skill and neuromuscular training on selected skill performance variables among state level male badminton players.

HYPOTHESIS

It was hypothesis that there would be significant improvement on selected skill performance variables due to specific skill training and neuromuscular training among state level male badminton players.

METHODOLOGY

The purpose of the study was to examine the effect of specific skill and neuromuscular training on selected skill performance variables among state level male badminton players. To achieve the purpose of the study thirty (N=30) state level male badminton players were selected randomly from Chennai city. They would be assigned into three group's namely experimental group I (Specific skill training), experimental group II (Neuromuscular training) and group III acted as Control Group. Their ages ranges from 17 and 19 years. They are selected only badminton players. After analyzing the various factors associated with the presented in this study. The following skill performance variable such as fore hand and back hand clear were tested to Poole

fore hand and back hand clear test. The collected data were analysed statistically ANCOVA. The level of significant was set at $P < 0.05$ level of confidence. Specific Badminton skill training can be initially categorised into on-court and off-court work. On-court work would mean training with badminton movements with a racket and usually with a shuttle. Off-court work

is usually additional work that has the aim of enhancing some particular aspect of fitness. Neuromuscular training is to improve the nervous system's ability to generate a fast and optimal muscle firing pattern, to increase dynamic joint stability, to decrease joint forces, and to learn movement patterns and skills.

RESULTS AND DISCUSSION

TABLE I
ANALYSIS OF VARIANCE COVARIANCE ON SKILL PERFORMANCE
VARIABLES OF CONTROL GROUP AND EXPERIMENTAL GROUP

Variables	Test	Ex I	Ex II	CG	SV	SS	df	MS	F
Fore Hand Clear	Pre test	45.00	46.60	45.20	B	15.20	2	7.60	1.49
					W	138.00	27	5.11	
	Post test	55.80	55.60	45.90	B	640.47	2	320.23	72.72*
					W	118.90	27	4.40	
	Adjusted	56.03	55.22	46.05	B	607.41	2	303.70	79.88*
					W	98.851	26	3.80	
	Mean Gain	-10.80	-9.00	-0.70					
Back Hand Clear	Pre test	45.80	47.30	45.90	B	14.07	2	7.03	1.60
					W	118.60	27	4.39	
	Post test	56.20	57.00	44.90	B	915.80	2	457.90	47.10*
					W	262.50	27	9.72	
	Adjusted	56.30	56.81	44.99	B	872.14	2	436.07	43.96*
					W	257.923	26	9.92	
	Mean Gain	-10.40	-9.70	1.00					

*Significant at 0.05 level of confidence for (df) 3 at 56 = 2.70 and for (df) 3 at 55 = 2.72

The results presented in Table I showed that the pre, post and adjusted post test mean value on fore hand clear and back hand clear for specific skill training group, neuromuscular training group and control group. The calculated F ratio of 72.72 and 47.10 was greater than

the required table value of 2.70 which indicated that there was significant improvement on fore hand clear and back hand clear after twelve weeks of specific skill training and neuromuscular training programme.

TABLE II
SCHEFFE'S POST HOC TEST ANALYSIS ON SKILL PERFORMANCE
VARIABLES OF CONTROL GROUP AND EXPERIMENTAL GROUP

Variables	Ex 1	Ex 2	CG	MD	CI
Fore Hand Clear and Back Hand Clear	56.03	55.22	-	0.81	2.26
	56.03	-	46.05	9.98*	2.26
	-	55.22	46.05	9.17*	2.26
	56.30	56.81	-	-0.51	3.65
	56.30	-	44.99	11.32*	3.65
	-	56.81	44.99	11.82*	3.65

*Significant at 0.05 level

The post hoc analysis of adjusted means proved that there were significant differences between the control group and specific skill training group, control group and neuromuscular training group were greater than the required confidential interval value. However, there was no significant difference between specific skill training and neuromuscular training group as the mean difference was lesser than the confidence interval value.

CONCLUSION

It was concluded that there was significant improvement on fore hand clear and back hand clear volleying ability among state level male badminton players. Lee et. al (2005), in their study the result showed that the top three most popular shots used were clear, lift and net. The results of the present study also confirmed the same by adding the forehand clear and back hand clear among state level badminton players, badminton serving ability place a vital role especially in the game of doubles.

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IMPACT OF SPECIFIC SKILL AND NEUROMUSCULAR TRAINING ON SELECTED PHYSICAL PHYSIOLOGICAL AND SKILL RELATED VARIABLES AMONG STATE LEVEL MALE JUNIOR BADMINTON PLAYERS

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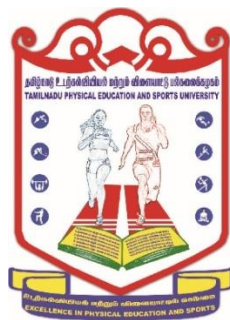
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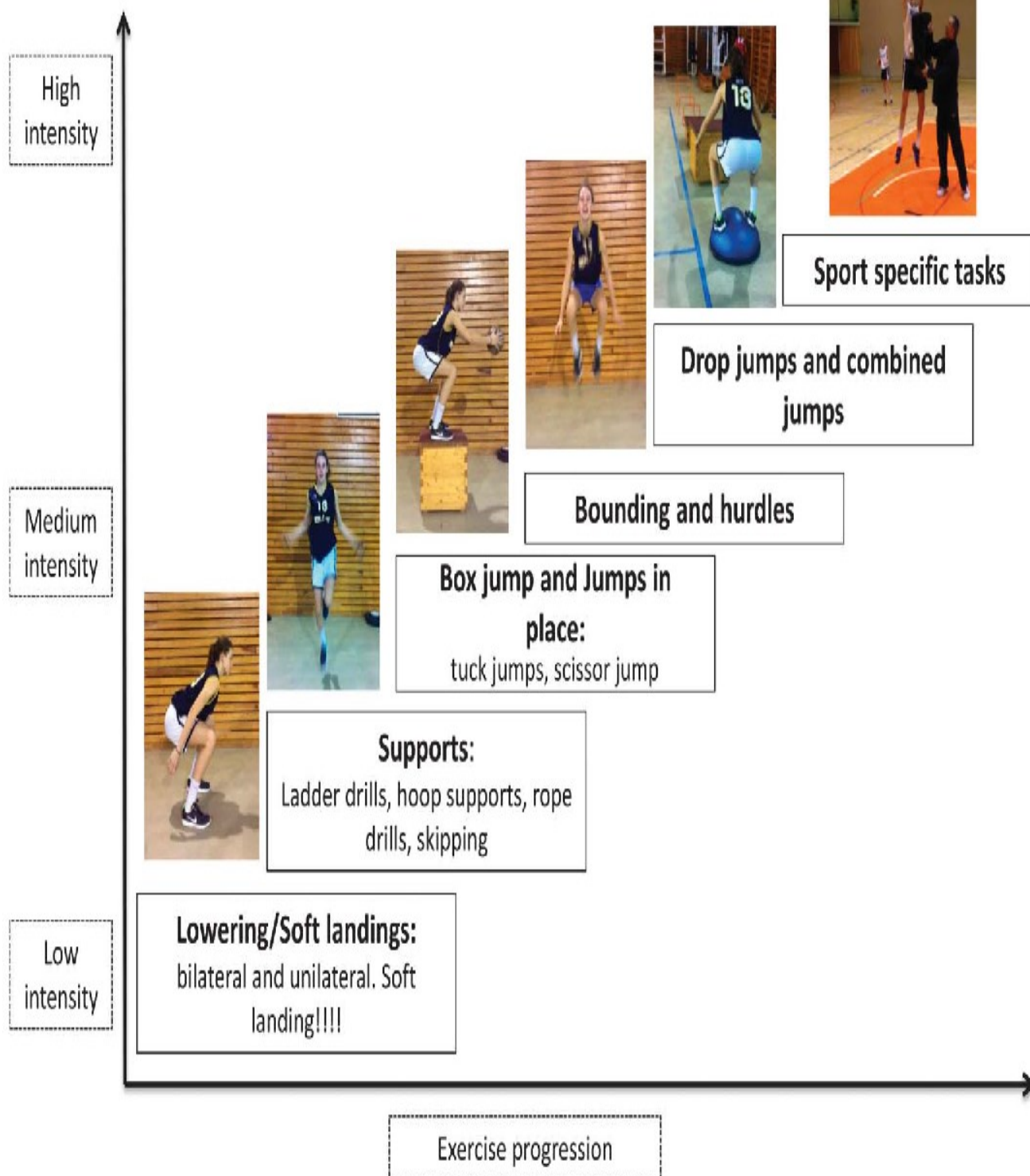
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